# THE EFFECT OF CHOSP ON HOUSING STARTS

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# Executive Summary

This study examines the effect of the Canadian Homeownership Stimulation Plan (CHOSP) on housing starts in Canada. Three aspects in particular are considered:

(i) the relative importance of declining interest rates and CHOSP to the miniboom in construction of single-detached housing in the 1982-83 period,

(ii) the extent to which CHOSP "brought forward" starts from the period after the termination of the program,

(iii) the spillover effect on rental starts and the effect on the quality of new housing.

The CHOSP effect on ownership housing starts is estimated in two ways: using an econometric equation of housing starts and using a system dynamics model. With the assumption that the CHOSP effect was lagged one quarter, the estimated four quarter impact of CHOSP using the econometric equation is a 36,800 unit increase. With no lag assumed, the estimated effect is a 32,400 unit increase.

Using a system dynamics model developed for this project, the estimated effect of CHOSP was shown to be an increase in starts of 28,140 units during the four quarter life of the program.

The dynamic model is also used to estimate the effect of declining interest rates by simulating the housing market under the assumption that interest rates were constant as of the beginning of the CHOSP program (beginning of the third quarter of 1982). The effect of declining interest rates estimated by the simulations is not significant until the last quarter of the CHOSP program. In that quarter, the interest rate effect, which represents an increase in starts of 11,120 units is significantly larger than the CHOSP impact of 6,260 units in that quarter. While CHOSP has a negative rebound effect after the termination of the program, the interest rate effect remains positive, increasing starts by an average of over 13,000 units per quarter to the end of the simulation runs (the end of 1984).

The extent to which CHOSP brought forward starts from later time periods is examined by the combination of a run designed to separate out the equilibrium effect of CHOSP (effect on starts if the CHOSP program had been expected to be permanent) and estimates of the decline in starts relative to the Base Case after the program was terminated. This approach indicated that the equilibrium effect is negligible, but the quarterly decline in starts during the post-CHOSP period is less than one-third as large as the initial quarterly impact of CHOSP. These findings suggest that CHOSP brought forward approximately 2,000 starts per quarter from the three years following the program. It therefore appears that the increase in starts during the CHOSP period was much more concentrated than the rebound effect in subsequent periods.

Overall, the findings support the conclusion that CHOSP stimulated construction activity in the housing industry. However, since the decline in starts in later periods offset the gains realised during the program, CHOSP appears to have had a stabilising effect in which it increased starts in the quarters before the stimulative effect of declining interest rates was felt. However, there was a slight reduction in starts once the interest rate effect took hold.

## Abstract

In this paper the effect on ownership housing starts of the Canadian Homeownership Stimulation Plan (CHOSP) and of declining interest rates in the period from mid-1982 to the end of 1984 are examined. The CHOSP effects are estimated both with a static model of housing starts and a dynamic model of the Canadian housing market.

The estimated impact of CHOSP using the static model was an increase of between 32,400 and 36,800 units during the period when the CHOSP program was active. The dynamic model estimated that the impact was 28,140 units. Virtually the entire impact represents starts brought forward from future years, with starts declining by 2,200 per quarter after the termination of the program.

Declining interest rates increased starts by between 11,120 and 16,260 units in each quarter from 1983-II (the last quarter of the CHOSP program) to the last quarter of 1984. Hence, it may be concluded that the CHOSP program smoothed housing construction activity by shifting starts from the period after the program when declining interest rates were stimulating activity to the late 1982 to early 1983 period when interest rates were still high enough to be depressing new housing starts. However, the tail end of the program overlapped with the period when the impact of declining interest rates was already being felt.

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# 1.0 Introduction

The purpose of this project has been to evaluate the impact of the Canadian Homeownership Stimulation Plan (CHOSP) on housing starts in the Canadian market.

Ideally, program evaluations should consider both the quantitative and qualitative effects of the program being evaluated, including:

- any change in the number of new housing units constructed;
- any change in the quality (size, location, and other features) of new units being built;
- any effects on the existing stock of housing (i.e. demolitions, conversions, maintenance of the existing stock, etc.)

This project has focused on the first effect, but also provides some indication of the latter two effects. Less confidence should be placed in the quality and change in existing stock measures than in the supply of new housing estimates, since available data are less reliable.

A two faceted approach has been used for the analysis. First, an equation for Canadian housing starts has been estimated econometrically. That equation includes, among other variables, a dummy variable for CHOSP; hence, it provides an estimate of the program's effect on housing starts. That technique, however, does not indicate the extent to which the increased starts during the CHOSP period were offset by a decline in starts in the years following the termination of the program (i.e., the magnitude of the rebound effect). It would not be expected that CHOSP grants would alter the decision of many households to own or rent. Rather, it primarily is expected to alter decisions regarding the timing of entry into the ownership market.

In order to estimate the magnitude of the rebound effect, a system dynamics model of the housing market has been developed and an estimate of the decline in housing starts in the period following the termination of the CHOSP program has been derived from simulations using the model. It is a disequilibrium model which utilizes econometric estimates of three key relationships in the ownership and rental sectors: supply, demand and price adjustment. The model also has been used to simulate the Canadian housing market under alternative scenarios which isolate the effects of CHOSP and the decline in interest rates in the same period.

The model used for the analysis was motivated by a model developed in 1981 for Ontario Ministry of Municipal Affairs and Housing by John Todd of Econalysis Consulting Services (ECS). The 1981 model was used to assess the impact of rent control on the supply, demand and price of rental housing, under several alternative policy scenarios, in two Ontario cities: Toronto and London. The paper prepared for the Ministry served as one of the background studies for the Ministry's staff research report entitled ***The Impact of Rent Review on Rental Housing in Ontario***.

While the 1981 model is similar to the current model in approach, they differ significantly in detail. The ownership sector of the 1981 model received little attention, since that model was used only to examine rental policies. The primary design objective for the ownership sector was to demonstrate the spillover effects of rental market dynamics. A more sophisticated approach to modelling the ownership sector was necessary to provide the current model with the capability of analysing ownership market policies such as CHOSP. The ownership sector, therefore, has been enriched to reflect the relevant housing literature.

To ensure consistency, the rental sector equations also have been re-specified. In addition, the empirical underpinnings of the model were reviewed in light of additional data and literature which have become available since 1981. All equations based on econometric analysis have been re-estimated and the specifications reconsidered, where appropriate. Finally, a sector has been added to simulate changes in the quality of new housing. This variable enables one to identify, within the model, the effect of CHOSP on the quality of new homes (as measured by liveable floor space), as well as on the number of houses purchased.

With these revisions, a greatly improved bi-sectoral system dynamics model of the housing market has been developed. The primary advantage is that it can be used to examine ownership, as well as rental housing policies. Furthermore, the interactive effects between the two sectors can be assessed with greater confidence.

The report is divided into four additional sections. Section 2 discusses the background to the Model. The structure of the Model is outlined in Section 3. Section 4 presents the results of the simulations assessing the impact of CHOSP and changing interest rates on housing starts in Canada. Section 5 briefly reviews some other results obtained from the model. Conclusions are presented in Section 6. The body of the report is presented in a non-technical manner, with more comprehensive material related to the development and structure of the model being in the four Appendices.

# 2.0 Background to the Model

This section of the Report briefly examines the benefits of using a system dynamics model of the housing market to evaluate housing programs such as CHOSP. It consists of two sub-sections which describe the CHOSP program and system dynamics as a modelling methodology.

## 2.1 Canadian Homeownership Stimulation Plan (CHOSP)

The Canadian Homeownership Stimulation Plan was intended to "stimulate residential construction and job creation" (Honourable A.J. MacEachen, "Budget Speech", June 28, 1982, p.8.). The success of CHOSP in achieving that objective rests with its effectiveness in increasing the number of housing starts relative to the construction activity that would have occurred in the absence or the program. Both the short-term and the long-term effects are relevant. The short-term effect is the increase in construction during the life of the CHOSP program. The long-term effect takes into account the subsequent rebound effect, which is the decline in starts after the termination of the program.

Assistance to both the purchasers of new homes and first-time purchasers of existing homes will stimulate starts. The former affects starts directly since potential buyers, whether first-time owners or existing owners wishing to move, will be encouraged to buy new, rather than existing housing. Demand for existing housing is reduced while demand for new homes is increased, affecting the prices of new and existing housing and the actual quantity demanded for ownership housing. The magnitude of these effects will depend on the elasticities of supply and demand.

Assistance to first-time buyers, whether they are purchasing a new or existing unit, increases demand for all ownership housing driving up prices generally. The extent to which the net result is increased construction versus higher prices depends on the supply and demand elasticities. In theory, the increased demand for existing housing should primarily increase the price of the fixed supply of existing housing; thereby increasing demand for new housing. If housing were homogeneous and new housing supply were perfectly elastic, the entire impact would translate into new housing starts since every induced purchase of an existing house would simply drive another purchaser into the market for new housing.

From July to December 1982, both first-time buyers of either new or existing housing and any purchaser of new housing qualified for CHOSP grants. As of January 1983, only the purchase of new housing qualified for grants. In total, about 50 per cent of the 265,000 grants disbursed were for new houses. CHOSP grants could be used to purchase buildings of up to 6 units; however, only one grant could be received for the purchase. Fully 83 per cent of the grants were used to purchase single-detached dwellings.

CHOSP acts as a 'shock' to the market system, causing it to deviate from the *ceteris paribus* adjustment path. The incentive program has the effect of temporarily decreasing the cost of purchasing new housing. The market response can be segmented into three component effects:

(i) changed relative lifetime costs of owning and renting housing (tenure substitution effect);

(ii) reduced absolute cost per unit of housing services purchased thereby increasing effective buying power (income effect).

(iii) changed relative present value cost of present and future housing purchases (speculative effect);

The tenure substitution effect can be expected to attract some households into the ownership sector that would otherwise never buy a home. This effect increases both short-term and long-term ownership demand; hence, the resulting increase in starts will be offset by the rebound effect. Only potential first-time buyers are affected.

The income effect can be expected to induce households to purchase more housing services than they otherwise would. The increase could take the form of higher quality, better location, larger floor space or any other factor which increases housing value. Both first time buyers and current owners interested in moving to qualifying new units are affected.

The speculative effect can be expected to induce some households to purchase homes sooner than they otherwise would have. This effect increases only short-term ownership demand and will be offset by future declines in demand. Only potential first-time buyers are affected. The simulation results show this to be the dominant effect since there is a significant increase in starts during the CHOSP period and an equally significant rebound effect in the post-CHOSP period.

The short-term effect of CHOSP, or any other temporary program, can be viewed as similar to speculation when a price increase is expected. Because buyers anticipate a price change, they time their purchase to minimize the discounted cost of their purchase, including financing costs. The magnitude of the speculative effect depends on the gradient of the price change. If a housing grant program is to be introduced, potential recipients who anticipate the program and expect to qualify are likely to delay their purchase. The larger the anticipated grant (and the greater the expected probability of qualifying), the longer the delay they would be willing to incur. Similarly, if termination of the program (or exhaustion of limited funds) is anticipated, then potential buyers will accelerate their purchase plans. Furthermore, it can be expected that as the termination date of the program approaches, the impact will increase.

Although the speculative effect cannot be statistically shown when only one incentive program is studied, a comparison of the actual and the simulated starts shows results that are consistent with this hypothesis.

The magnitude of these effects depends on various program parameters such as the restrictions on qualification, the size of the benefits, the perceived uncertainty about qualifying, other incentive programs and the short-run (since CHOSP was a short-run program) elasticities of supply and demand. The elasticities also determine the extent to which increased demand translates into higher prices rather than increased supply in equilibrating the market.

## 2.2 System Dynamics: The Modelling Methodology

Economic research frequently utilizes static equilibrium models to study the effects of economic "shocks" (unanticipated exogenous factors, such as new government policies or programs) on markets. However, in certain circumstances, the transitional effects of a program may be as important as the equilibrium effects. The transition path is of particular interest in markets which respond slowly to external shocks. In those circumstances, a modelling technique such as system dynamics, which simulates the continuous adjustment process in a market, is appropriate.

In the housing market, the transition path is of interest for several reasons. First, price adjustments are delayed by leases (in the rental market), by information imperfections and barriers to exit from the market (capital is long-lived and immobile). Second, the supply response to unanticipated price changes is delayed by the lags for assembling land, designing projects, getting plans approved and construction. Finally, demand responses may be delayed by high transaction costs and imperfect information, among other things.

System dynamics is a methodology which allows modellers to incorporate the transitional process into their models. Unlike econometric modelling which involves solving a set of simultaneous equations for each time period, system dynamics continuously adjusts the level of certain variables (such as price) at rates which also change in response to other system variables (such as the balance between supply and demand).

System dynamics is particularly attractive for modelling hypothetical scenarios for which data are limited. Theoretically-based specifications of a market can be explored with a computer model which enables the theory to be tested for internal consistency and for consistency with mental or *ad hoc* models where analytic models are too complex to "solve."

Many modelling techniques, such as econometric modelling, are limited by the availability and quality of data. Data deficiencies may force the modeller to use the best available proxy, or to drop some variables. Parameter estimates that are inconsistent with theory or other empirical experience, must be accepted unless the modeller is prepared to change the specification of the model.

The approach in this study was to develop a system dynamics model based on the contemporary housing literature. The principal relationships were estimated econometrically but where data were scant, certain secondary relationships were included without formal parameter estimates, rather than being ignored due to lack of data.

# 3.0 Overview of the Model

This section provides a brief conceptual description of the model used for assessing the dynamic effect of CHOSP on housing supply. A more detailed technical presentation is provided in Appendix A. This overview consists of two sections, the first describing the general structure of the model and the second looking specifically at the treatment of CHOSP.

## 3.1 The Model's Structure in Brief

As discussed in Fallis (1985), the standard model of housing services treats housing as a standard commodity which is exchanged in a market. It has three key components: supply, demand and price. The system dynamics model developed for this project is based on that standard approach but is extended by disaggregating the housing market into distinct submarkets for rental and ownership housing.

The model permits short run disequilibria between supply and demand, taking the form of vacancy rates that deviate from the normal vacancy rate. Price, therefore, is not the market clearing price, but rather a price which changes in response to the vacancy rate to move the market toward equilibrium. The lag in the price response reflects the rigidities and heterogeneity of the market.

### DEMAND

Market demand is determined by economic and demographic factors. In the model, ownership and rental demand are each a function of five exogeneous variables and two endogenous variables. The exogenous variables are (1) a "normalized" estimate of the number of households, (2) real household income, (3) inflation, (4) the real mortgage interest rate, and (5) the difference between mortgage and bond rates. The endogenous variables are indexes of the prices of ownership and rental housing.

In the ownership demand equation, ownership price reflects the price net of the CHOSP grant in the relevant four quarters. In addition, a term is included to reflect speculative demand stimulated by CHOSP. Those CHOSP terms are discussed more fully in section 3.2 below.

The demand equations for both the rental and the ownership sectors have been econometrically estimated using quarterly Canadian data for the 1976 to 1984 period.

### SUPPLY

The future housing stock in each sector of the market is determined by the existing stock, adjusted by additions through new construction and conversion from other types of residential use and from non-residential uses and by deletions through demolition or conversion to other uses. The variable of primary interest for the evaluation of CHOSP is the quantity of new housing starts, which in turn determines completions.

Completions equal housing starts lagged using the delay function available in *DYNAMO* (the simulation language used for the model). The effective average delay time is about 20 weeks.

Starts have been econometrically estimated for each sector (ownership and rental), as a function of four independent variables plus three seasonal dummy variables. A dummy variable for CHOSP also is included for ownership starts. The four independent variables are: (1) the relevant housing price index (rental or ownership) in real terms, (2) the housing construction costs index in real terms, (3) the expected real mortgage rate, and (4) the difference between the mortgage and bond rates.

The rate of investment or disinvestment in the housing market depends on the anticipated return on investment in housing relative to the anticipated return on alternative opportunities. In the model, therefore, economic factors affect the changes to the demolitions and conversions rates. The owned and rented demolition rates each equal a normalised rate which is modified by the ratio of the relevant price index to the rate of inflation. Both conversion rates (owned to rented and rented to owned) depend on the ratio of the ownership and rental price indices.

It is worth noting that in the housing literature, housing supply is commonly measured in terms of the value of investment. The rate of change in the total investment can be divided into two components: the change in the number of units, and the change in the average quality of those units. The model tracks the number of housing units and the quality separately. There is no investment variable. The determinants of quality and quantity, however, are the same variables as those which determine the rate of investment in investment-oriented models. The quality sector of the model is discussed below.

**QUALITY OF HOUSING**

As noted above, the supply of housing services consists of two dimensions: quantity and quality. A supply incentive may affect either or both dimensions. The model has a housing quality variable in each sector which captures changes in the cost of new units supplied to the market, adjusted for changes in construction costs. Hence, the effect of CHOSP on the quality (larger houses with more features) of new houses purchased can be identified separately from the effect on quantity.

Quality was econometrically estimated for new ownsership housing. A housing quality proxy was defined equals the average liveable floor area of new housing (single-detached dwellings financed under the NHA as reported in CMHC Canadian Housing Statistics). Ownership quality was estimated as a function of one endogenous variable (the real price of new ownership housing) and one exogenous variable (household income).

**PRICE**

If the housing market were perfectly competitive, price would be homogenous throughout the market and would respond instantly to supply and demand pressures. It would be the price which equilibrates the market. In reality there are numerous rigidities; hence, price responds to changing market conditions with a delay. The simulation model, therefore, does not assume that market equilibrium is maintained. Rather price moves toward the equilibrium at a rate determined by the degree of disequilibrium.

The principal variables in the ownership and rental price sectors are the rates of change in the relevant price indices. They are functions of the respective vacancy rates, the inflation rate and the real mortgage rate. Both price change equations have been estimated econometrically.

It should be noted that prices in the ownership market are affected by speculation, causing price movement to violate basic economic principles in the short-run. For example, Grebler and Mittelbach (1979, p. 5) note that during the 1975-77 period of rapid price escalation in California, demand increased, rather than decreased, since buyers rushed into the market to acquire houses under the assumption that it was their "last chance to buy." The model does not capture the effects of speculation, which are assumed to be random. Random factors are inherently unpredictable and, therefore, form part of the residual in the estimated price equation.

**DYNAMICS OF THE MODEL**

Taking supply, demand and price together, there is a 'dynamic feedback system' which forms the market mechanism as modelled. A 'shock' to the market system, such as the introduction of CHOSP, works its way through all sectors of the model. For example, a price change gives rise to both a supply and a demand response, which will take several periods to work through the market fully. The supply and demand responses, or changes in supply or demand due to other factors, may give rise to a disequilibrium between supply and demand which will alter the rate of price change variable, thereby moving the market price toward equilibrium.

## 3.2 Treatment of CHOSP

To incorporate CHOSP into the model, it was necessary to consider not only the impact of the reduction in the effective price of new houses on the market equilibrium, but also the effect of the termination of the program on the timing of purchases. In this paper, the former effect is referred to as the "equilibrium effect" (it combines the income and the tenure substitution effects discussed in section 2.1) and the latter as the "speculative effect." Since they are handled in quite different ways in the model, they are discussed separately below.

The equilibrium effect reflects what would have been the impact if the CHOSP program was expected to be permanent. A few additional households would have been attracted into the ownership market. That effect is small, however, compared to the shift in demand from the post-CHOSP period to the period when CHOSP grants were available - the speculative effect.

**EQUILIBRIUM EFFECT**

CHOSP grants were payments to purchasers of residential premises of up to six units. The textbook treatment of a subsidy paid to consumers is to shift the effective demand curve upward by the amount of the subsidy (for example, in Henderson and Quandt (1971) pp. 275-76). That approach shows the increase in equilibrium demand stimulated by the decrease in the effective price. It does not reflect any shift in demand from one time period to another. This standard approach was used to capture the equilibrium effect of CHOSP on housing starts. Specifically, since CHOSP lowered the effective ownership price for qualified buyers without reducing the price received by sellers, it is modelled as a reduction in the effective ownership price in the ownership demand equation. The market price determined by the price equation is not directly affected.

The effect of CHOSP on the effective price depends on a number of factors. The most important are: the average grant value, the value of provincial stacking, the rules determining the proportion of potential buyers that qualify, the level of awareness of the program among potential buyers, and the take-up rate among qualified, aware buyers.

Due to the latter three factors, it is not valid to simply reduce the effective price in the demand equation by the average value of CHOSP grants. Doing so would overestimate the impact of CHOSP. Ideally, the model would explicitly incorporate the proportion of buyers who qualify and are aware, and the take-up rate of the program. That could not be done, however, since the required data are not available. Instead, a single price-adjustment factor reflecting all of the influences is built into the model.

The CHOSP price-adjustment factor reduces the effective price in the demand equation by 3 per cent of the 1981 price level during the four quarters from the third quarter of 1982 to the second quarter of 1983. That was a generous assumption and would be consistent with an 80 per cent qualification rate, an 80 per cent awareness level, an 80 per cent take-up rate, an average CHOSP grant value of $3,000 plus $2,000 in provincial stacked subsidies, and an average selling price for qualified units of $85,000. Hence, the results of the simulations should be considered to be upper limit estimates of the impact of CHOSP. Even with those generous assumptions, the equilibrium effect of CHOSP was found to be negligible. That finding is discussed in detail in the section 5.0. It may be noted that since the equilibrium effect of CHOSP was found to be so small, the simplification of the methodology for modelling the CHOSP effect on demand does not seriously compromise the simulation results, either qualitatively or quantitatively.

Based on theory, one expected impact of CHOSP is an increase in the the market price of new houses relative to the price of existing houses since more buyers of new houses qualified for grants than did purchasers of existing housing. The differential impact would be expected to be largest in the later phase of the CHOSP program when only new housing qualified, but it would have also been expected in the early days of the program (existing housing purchased by first-time buyers also qualified) since only a fraction of the demand for existing homes would have been affected.

A further expected effect of CHOSP is the stimulation of supply in response to the increased price. That implies an increase in ownership housing starts. Since some of the demand would be diverted from rental demand, the expected spillover effects into the rental market would be decreased demand, decreased price and, as a result, decreased supply.

**SPECULATIVE EFFECT**

The most significant effect of CHOSP is the speculative effect. It reflects the accelerated rate of housing purchases that occurred in anticipation of the termination of the CHOSP program. The speculative effect is modelled by incorporating dummy variables into the ownership starts, price and demand equations.

A preliminary run of the model with the speculative effect set to zero showed that the equilibrium effect was close to zero. That run is reported in section 5.1. As a result, it was assumed that the static analysis CHOSP effect identified by estimating the starts equation could be considered to be fully explained as the speculative effect. The discussion of the dynamic analysis in the next chapter also considers the total CHOSP effect to be explained as the speculative effect.

# 4.0 The Effect of CHOSP on Housing Starts

## 4.1 Methodology

The analysis is divided into two parts: the static and the dynamic analyses. The first part estimates the impact of CHOSP on housing starts using an econometric equation for ownership housing starts. The second uses the housing market model to estimate the CHOSP impact through to the end of 1985. Since the starts equation used in the static analysis is also used as a component of the dynamic model, the static and dynamic results ae compared to determine the relative explanatory power of the alternative approaches.

**STATIC ANALYSIS**

An ownership housing starts equation has been estimated. The independent variables in the econometric equation are: (1) the ratio of the relevant housing price index (rental or ownership) to the housing construction costs index, (2) the rate of inflation (3) the difference between mortgage and bond rates, and (4) the expected real mortgage rate. Dummy variables were included for seasonal variations in starts and for the effect of CHOSP. The equation was estimated using quarterly data for the 1976 to 1984 period. (A discussion of the specification, the data and the results is provided in Appendix C.)

**DYNAMIC ANALYSIS**

The model described in section 3.Ø was used for four simulation runs which are reported in this section (a fifth simulation, Run #2, is discussed in section 5.Ø):

1. actual market conditions, including CHOSP (Run #1);
2. actual interest rates since 1978, no CHOSP (Run #3);
3. interest rates stable since 1982, CHOSP present (Run #4); and
4. interest rates stable since 1982 and no CHOSP (Run #5).

Run #1 is referred to as the Base Case since it simulates actual market conditions and is used as the reference base for the other simulations. Using the above runs, the effects of CHOSP and reduced interest rates are determined as follows:

The impact of CHOSP is determined by comparing runs 1 and 3. The impact of declining interest rates is present in both runs, while the impact of CHOSP is felt only in run 1.

The impact of the decline in interest rates is isolated by comparing runs 1 and 4. CHOSP is present in both runs, while the nominal and real interest rates are held constant at the level reached at the end of the second quarter of 1982. To maintain consistency, the bond rate and hence the difference between the mortgage and bond rates also were held constant during that time period.

Comparing runs 1 and 5 shows the combined effect of CHOSP and declining interest rates. That comparison is useful for determining whether the combined effect of CHOSP and interest rates differs from the sum of the individual effects.

The findings for the comparison of each alternative scenario to the Base Case are presented in section 4.3, below.

## 4.2 Results of the Static Analysis

Two versions of the starts equation were estimated:

1. CHOSP dummy equals 1 for 1982-III to 1983-II,
2. CHOSP dummy equals 1 for 1982-IV to 1983-III (impact lagged).

The parameter estimates for the CHOSP dummy variable are given below, with their t-statistics and the adjusted $R^2$ for each equation. The estimated equations are reported fully in Appendix C.

| | Parameter Estimate | t-Statistic | $R^2$ | Estimated Four Quarter Starts |
|---|---|---|---|---|
| 1. Standard | 8.105 | 2.50 | 0.731 | 32,420 units |
| 2. Lagging CHOSP | 9.194 | 2.98 | 0.750 | 36,776 units |

The estimated total effect of CHOSP on housing starts, therefore, is in the range of 32,000 to 37,000 units, depending on whether the standard or lagged specification is accepted. In the system dynamics model, the standard specification was used for the ownership housing starts equation.

The static model was also used to estimate starts for each period from 1981-I to 1984-IV, the period simulated by the dynamic model. The estimates were generated using the actual values of the independent variables for each quarter. The results are presented in Table 5.6 in the next section of the report where they are compared to the actual starts and the Base Case starts generated by the simulation model.

## 4.3 Results of the Dynamic Analysis

The discussion of the results of the dynamic analysis is divided into three sections corresponding to the three hypotheses stated in the terms of reference for the project:

- the impact of CHOSP on housing starts,
- CHOSP "brought forward" ownership demand, and
- CHOSP combined with lower interest rates to stimulate demand.

All tables and figures appear at the end of the section (pages 16 to 19).

## THE IMPACT OF CHOSP ON HOUSING STARTS

Table 4.1 presents the estimates of housing starts as determined by the system dynamics model for each of the four scenarios. The runs are compared in Table 4.2. The effect of CHOSP on starts is shown under two alternate assumptions: actual interest rates (Run 1-3), and interest rates held constant (Run 5-4). The quarterly effects, annual effects, the four year (1981 to 1984) total effect, and the effect over the CHOSP period (1982-III to 1983-IV) are all shown. The estimated effects under the two assumptions are virtually identical; hence, only the actual interest rate simulation is discussed below. The quarterly and cumulative results for Run #1 (Base Case), Run #3 (No CHOSP) and Run #4 (Constant Int. Rate) are presented graphically in Figure 4.1 and 4.2, respectively.

The estimated effect of CHOSP on housing starts during the four quarters from 1982-III to 1983-II was an increase in starts of over 28,000 units, or an average of 7,000 per quarter. That is about 15 per cent less than the corresponding static model's estimated impact of CHOSP. The difference between the static and dynamic models reflects the different assumptions inherent in the two approaches. The static analysis assumes that the impact is constant over the four quarters, whereas the dynamic analysis assumes that the full impact is felt only at the beginning of the first quarter that CHOSP grants are available. After that, the increased demand stimulated by CHOSP drives price up and reduces effective demand, relative to the static analysis. The result is that the quarterly CHOSP effect declines steadily from 7,860 units in the first CHOSP quarter to 6,250 in the fourth quarter (in the actual interest rates simulation).

The model does not capture all of the factors which affect the pattern of the CHOSP effect during the life of the program. Comparing the actual starts to the simulations provides an indication of some of those factors. Specifically, the actual total starts in 1982 are much closer to the 1982 No CHOSP simulation results than the Base Case, reflecting low actual starts in the second and third quarters of 1982. Actual starts are higher than in the Base Case in 1983, with the difference being most significant in the second quarter (the last quarter during which CHOSP grants were available). That pattern indicates that the impact of CHOSP on demand was not constant through time, as is implicitly assumed by the model.

Two reasons for those differences may be noted. First, the impact of CHOSP appears to have been delayed by one quarter since the 1982-III actual starts were close to the No CHOSP level while the 1982-IV starts were close to the Base Case level. That observation is backed up by the fact that the lagged equation had a higher t-statistic than the non-lagged equation in the static analysis. Second, actual starts in the last quarter of the CHOSP program were greater than the Base Case estimate, indicating that the effect of CHOSP was concentrated in the wind-up period, rather than being constant throughout the program. It appears that the CHOSP effect increases during the program. Since that observation is based on data for only one incentive program, however, a statistically significant conclusion cannot be drawn. Nevertheless, the data describe an intuitively reasonable picture which may be worth considering further by examining the data for a number of incentive programs.

Table 4.2 also shows that it makes little difference whether the CHOSP effect is determined with actual interest rates (Run 1-3) or with the interest rate effect removed (Run 5-4). In both cases, the total simulated effect of CHOSP during the program is 28,140 units, although there are differences in the quarterly figures. The cumulative rebound effect is slightly smaller for the constant interest rate run which indicates that the rebound effect is smaller at higher interest rates.

**CHOSP "BROUGHT FORWARD" OWNERSHIP DEMAND**

CHOSP had important dynamic effects which are shown in Table 4.2 and Figure 4.1. Starts in the six quarters following the termination of CHOSP were 13,220 units (or an average of 2,200 per quarter) less than they would have been in the absence of CHOSP. That rebound effect occurs because after the termination of the program the market equilibrium returns to its normal path leaving an effective oversupply of ownership housing. Starts decline relative to what they would have been in the absence of CHOSP. In other words, the primary effect of the CHOSP subsidy is to bring demand forward in time by inducing households who were almost ready to buy their first home, to buy a little sooner. It does not stimulate households that would not have bought anyway to enter the ownership market; hence, demand is not permanently increased.

The magnitude of the rebound effect is almost constant during the six post-CHOSP quarters simulated. That result conflicts with the predictions of a simple static equilibrium model in which the cumulative CHOSP effect would be fully offset in the first period after the program terminates. The dynamic simulation differs from that result since the price response to a supply-demand disequilibrium is lagged.

As a further check of the rebound effect, the starts equation was re-estimated with a dummy variable for the post-CHOSP period (see Appendix C). The coefficient on that variable was -1.034, which was not significant (t-statistic, 0.27). That result implies that the rebound effect was not significant, with a best estimate of the effect being that starts declined by just over 1000 units per quarter in the post-CHOSP period.

**CHOSP COMBINED WITH LOWER INTEREST RATES TO STIMULATE DEMAND**

The effect of interest rates on starts also is shown in Table 4.2 (Run 3-4). Nominal mortgage rates (and the difference between the mortgage and bond rates) peaked in the second quarter of 1982, just before the CHOSP program was introduced. Inflation had peaked in the previous quarter, however, and real mortgage rates did not peak until the following quarter. The "Constant Interest Rate" run of the model froze all interest rates at their 1982-II levels which, from an historical perspective, were exceptionally high. The model shows that if those interest rate levels had been maintained, starts would have been slightly higher (interest rate effect was negative) in the last two quarters of 1982 and lower thereafter. The initial interest rate effect is negative since the constant interest rate scenario cuts off the real mortgage rate peak which occurred later than the nominal interest rate peak and because the interest rate effects are lagged. (see Appendix C for details of the econometrics).

The net interest rate effect in the first three quarters of the CHOSP program is close to zero. However, it became quite substantial after that. The interest rate effect exceeds 10,000 units in each quarter from 1983-II to the end of the run, 1984-IV. The relative importance of the CHOSP and interest rate effects are clearly illustrated in Figures 4.1 and 4.2 which plot the quarterly and cumulative effects respectively for the three simulations: (i) Base Case (#1), which includes both the CHOSP and the interest rate effects, (ii) No CHOSP (#3), which includes the interest rate but not the CHOSP effect, and (iii) Constant Interest Rate (#4), which includes neither the CHOSP nor the interest rate effect. It is evident that the positive CHOSP effect strongly dominated the negative interest rate effect in the first two CHOSP quarters. Both were positive and significant in the latter two CHOSP quarters, then the positive interest rate effect strongly dominated the negative CHOSP effect in the post-CHOSP period.

Table 4.2 also permits a comparison of the combined CHOSP and interest rate effect when each is run separately and the joint effect when they are run together. The joint effect is approximately 500 unit (0.5 per cent) less than the sum of the individual effects over the period simulated. Although a slight difference results since some of the relationships in the model are non-linear, the two sets of results can be considered to be virtually identical.

**TABLE 4.1 OWNERSHIP STARTS**
**ACTUAL AND SIMULATION RUNS**
**(000's of units)**

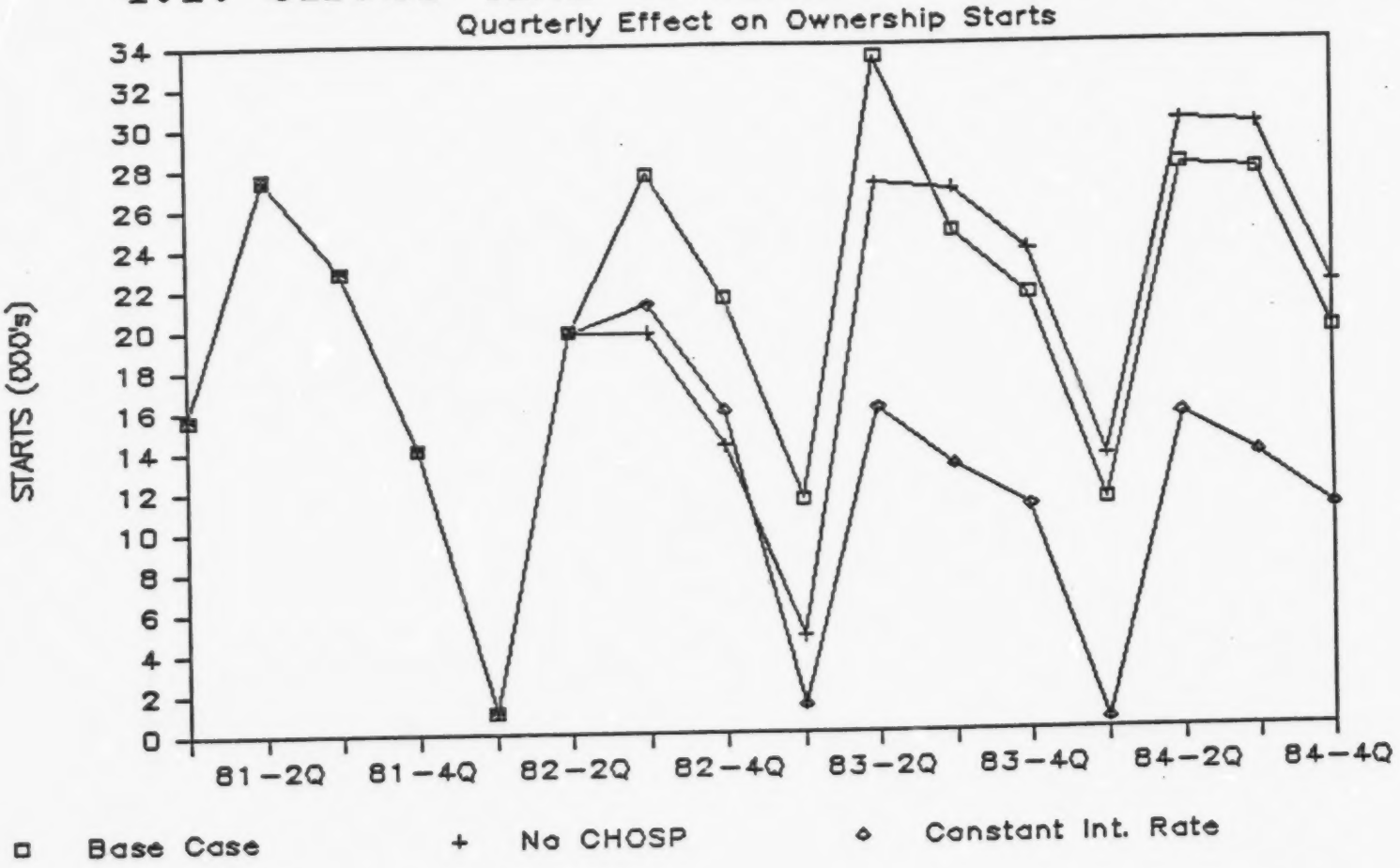
| | Actual Starts | Base Case (Run #1) | No CHOSP (Run #3) | No CHOSP & Constant Int. Rates (Run #4) | CHOSP & Constant Int. Rates (Run #5) |
|---|---|---|---|---|---|
| 1981- I | 15.964 | 15.69 | 15.69 | 15.69 | 15.69 |
| II | 35.113 | 27.5 | 27.5 | 27.5 | 27.5 |
| III | 26.029 | 22.92 | 22.92 | 22.92 | 22.92 |
| IV | 11.965 | 14.14 | 14.14 | 14.14 | 14.14 |
| 1982- I | 6.697 | 1.14 | 1.14 | 1.14 | 1.14 |
| II | 14.272 | 19.86 | 19.86 | 19.86 | 19.86 |
| III | 13.792 | 27.7 | 19.83 | 21.24 | 29.11 |
| IV | 19.696 | 21.51 | 14.24 | 15.99 | 23.29 |
| 1983- I | 15.373 | 11.57 | 4.83 | 1.43 | 8.16 |
| II | 44.442 | 33.41 | 27.15 | 16.03 | 22.27 |
| III | 22.643 | 24.76 | 26.88 | 13.18 | 11.08 |
| IV | 19.927 | 21.66 | 23.85 | 11.12 | 8.98 |
| 1984- I | 12.488 | 11.43 | 13.63 | 0.54 | -1.57 |
| II | 27.527 | 27.96 | 30.15 | 15.65 | 13.57 |
| III | 24.432 | 27.68 | 29.9 | 13.63 | 11.53 |
| IV | 19.204 | 19.79 | 22.01 | 10.96 | 8.86 |
| 1981 | 89.071 | 80.25 | 80.25 | 80.25 | 80.25 |
| 1982 | 54.457 | 70.21 | 55.07 | 58.23 | 73.4 |
| 1983 | 102.385 | 91.4 | 82.71 | 41.76 | 50.49 |
| 1984 | 83.651 | 86.86 | 95.69 | 40.78 | 32.39 |
| 1981-84 | 329.564 | 328.72 | 313.72 | 221.02 | 236.53 |
| 1982-III to 83-II | 93.303 | 94.19 | 66.05 | 54.69 | 82.83 |

**TABLE 4.2 OWNERSHIP STARTS**
**COMPARISON OF SIMULATION RUNS**
(000's of units)

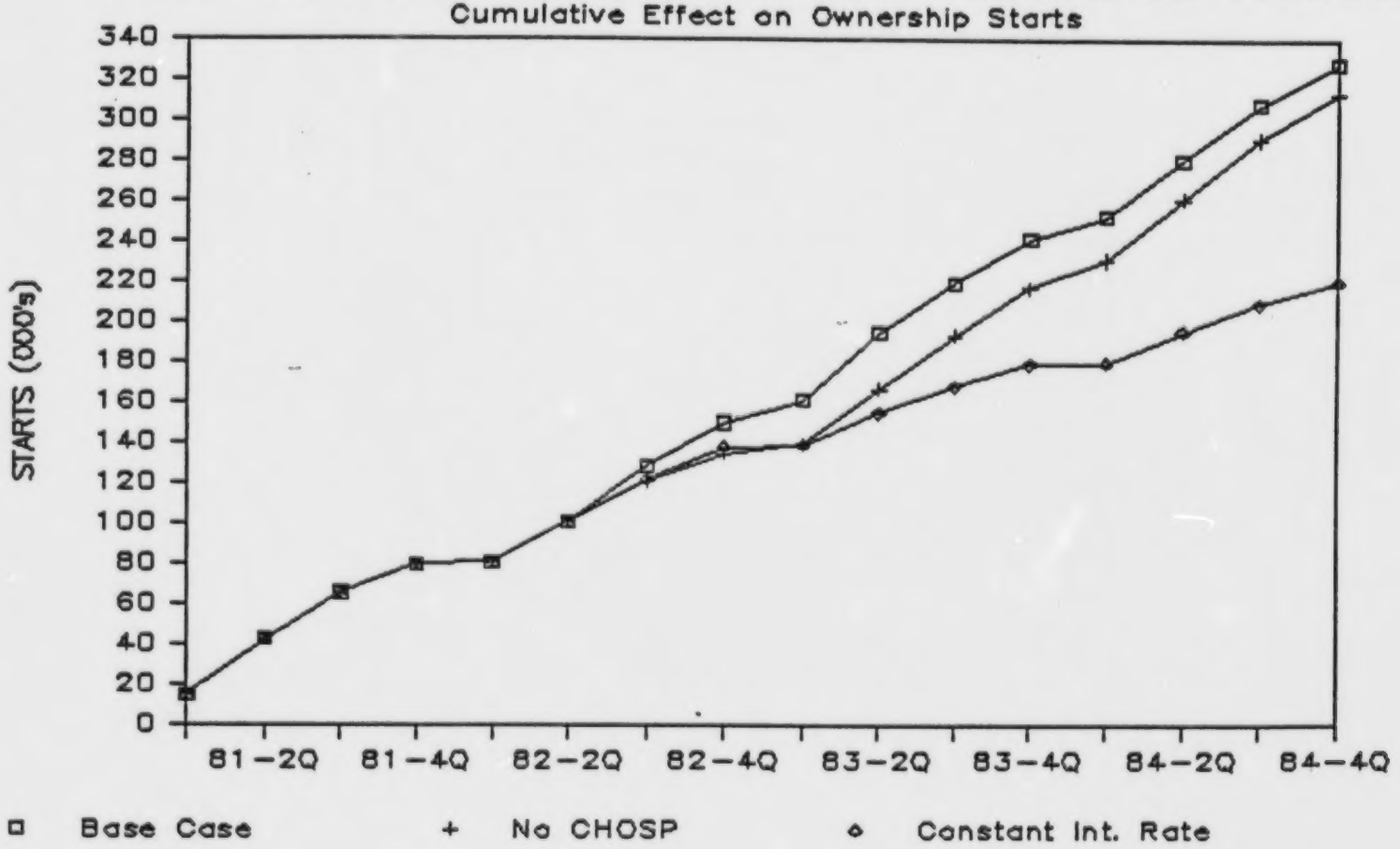
| | CHOSP Effect | Interest Rate Effect | Combined Effect | CHOSP with Constant Int. Rate | CHOSP + Int. Rate Effects* |
|---|---|---|---|---|---|
| | (Run 1-3) | (Run 3-4) | (Run 1-4) | (Run 5-4) | |
| 1981- I | Ø | Ø | Ø | Ø | Ø |
| II | Ø | Ø | Ø | Ø | Ø |
| III | Ø | Ø | Ø | Ø | Ø |
| IV | Ø | Ø | Ø | Ø | Ø |
| 1982- I | Ø | Ø | Ø | Ø | Ø |
| II | Ø | Ø | Ø | Ø | Ø |
| III | 7.87 | -1.41 | 6.46 | 7.87 | 6.46 |
| IV | 7.27 | -1.75 | 5.52 | 7.3 | 5.55 |
| 1983- I | 6.74 | 3.4 | 1Ø.14 | 6.73 | 1Ø.13 |
| II | 6.26 | 11.12 | 17.38 | 6.24 | 17.36 |
| III | -2.12 | 13.7 | 11.58 | -2.1 | |
| 11.6 | | | | | |
| IV | -2.19 | 12.73 | 1Ø.54 | -2.14 | 1Ø.59 |
| 1984- I | -2.2 | 13.Ø9 | 1Ø.89 | -2.11 | 1Ø.98 |
| II | -2.19 | 14.5 | 12.31 | -2.Ø8 | 12.42 |
| III | -2.22 | 16.27 | 14.Ø5 | -2.1 | 14.17 |
| IV | -2.22 | 11.Ø5 | 8.83 | -2.1 | 8.95 |
| 1981 | Ø | Ø | Ø | Ø | Ø |
| 1982 | 15.14 | -3.16 | 11.98 | 15.17 | 12.Ø1 |
| 1983 | 8.69 | 4Ø.95 | 49.64 | 8.73 | 49.68 |
| 1984 | -8.83 | 54.91 | 46.Ø8 | -8.39 | 46.52 |
| 1981-84 | 15 | 92.7 | 1Ø7.7 | 15.51 | 1Ø8.21 |
| 1982-III to 83-II | 28.14 | 11.36 | 39.5 | 28.14 | 39.5 |

* Sum of CHOSP effect at constant interest rates and interest rate effect.

# 4.1: CHOSP AND INTEREST RATE EFFECTS



# 4.2: CHOSP AND INTEREST RATE EFFECTS



# 5.0 Other Results of the Simulation Model

Although the primary focus of this paper is the effect of CHOSP on ownership housing starts, this section examines several other findings provided by the simulations using the model. The topics considered are:

1. the equilibrium effect versus the speculative effect of CHOSP on housing starts,

2. the effect of CHOSP on housing quality,

3. the spillover effect of CHOSP on rental housing starts, and

4. the comparison of the actual and simulated starts.

## 5.1 Equilibrium Effect versus Speculative Effect

The equilibrium and speculative effects of CHOSP are explained in section 3.2. The Base Case and No CHOSP runs, for which results are presented in Table 4.1 show the total effect of CHOSP. To separate out the the equilibrium effect, a simulation was run with CHOSP affecting only the ownership price variable in the demand equation. The simulation results for the No Spec(ulation) run are presented in Table 5.1 and compared with the total effect of CHOSP on housing starts.

As measured by the simulation runs, the equilibrium effect is negative during the CHOSP period, as well as after it. That result is contrary to theory. A problem arises because the effect is too small for the model to capture properly. The relationship between the supply-demand equilibrium and price in the ownership sector is non-linear with discontinuities. Small changes in the area of the discontinuities can produce inconsistent results, although larger changes cause no problem. As a consequence, the only conclusion that can be drawn about the equilibrium effect is that it is negligible: less than one per cent of the speculative effect.

## 5.2 Housing Quality

The project proposal indicated that the model would be used to examine the effect of CHOSP on the quality of new ownership housing, as well as the quantity. An equation for quality was specified for the model and it was estimated econometrically, as is discussed in section 3.1. The quality index for the Base Case, the No CHOSP run and the No CHOSP, Constant Interest Rate run are compared in Table 5.2.

It is apparent that the quality index follows a cyclical pattern, reflecting the fact that the income variable used in the model is not seasonally adjusted. It is not clear whether that corresponds to actual quality seasonality since the data used in the econometrics were available only on an annual basis. Hence, only the annual changes in quality should be considered significant. Nevertheless, quarterly results are reported for the purpose of comparing the three runs.

**TABLE 5.1 OWNERSHIP STARTS**
**EQUILIBRIUM VERSUS SPECULATIVE EFFECTS**
**(000's of units)**

| | Base Case | Equilibrium Effect of CHOSP | No CHOSP | Equilibrium Effect | Speculative Effect |
|---|---|---|---|---|---|
| | (Run #1) | (Run #2) | (Run #3) | (Run 2-3) | (Run 1-2) |
| 1981- I | 15.69 | 15.69 | 15.69 | Ø | Ø |
| II | 27.5Ø | 27.5Ø | 27.5Ø | Ø | Ø |
| III | 22.92 | 22.92 | 22.92 | Ø | Ø |
| IV | 14.14 | 14.14 | 14.14 | Ø | Ø |
| 1982- I | 1.14 | 1.14 | 1.14 | Ø | Ø |
| II | 19.86 | 19.86 | 19.86 | Ø | Ø |
| III | 27.7Ø | 19.82 | 19.83 | -Ø.Ø1 | 7.88 |
| IV | 21.51 | 14.22 | 14.24 | -Ø.Ø2 | 7.29 |
| 1983- I | 11.57 | 4.8Ø | 4.83 | -Ø.Ø3 | 6.77 |
| II | 33.41 | 27.13 | 27.15 | -Ø.Ø2 | 6.28 |
| III | 24.76 | 26.87 | 26.88 | -Ø.Ø1 | -2.11 |
| IV | 21.66 | 23.82 | 23.85 | -Ø.Ø3 | -2.16 |
| 1984- I | 11.43 | 13.6Ø | 13.63 | -Ø.Ø3 | -2.17 |
| II | 27.96 | 3Ø.14 | 3Ø.15 | -Ø.Ø1 | -2.18 |
| III | 27.68 | 29.87 | 29.9Ø | -Ø.Ø3 | -2.19 |
| IV | 19.79 | 21.99 | 22.Ø1 | -Ø.Ø2 | -2.2 |
| 1981 | 8Ø.25 | 8Ø.25 | 8Ø.25 | Ø | Ø |
| 1982 | 7Ø.21 | 55.Ø4 | 55.Ø7 | -Ø.Ø3 | 15.17 |
| 1983 | 91.4Ø | 82.62 | 82.71 | -Ø.Ø9 | 8.78 |
| 1984 | 86.86 | 95.6Ø | 95.69 | -Ø.Ø9 | -8.74 |
| 1981-84 | 328.72 | 313.51 | 313.72 | -Ø.21 | 15.21 |
| 1982-III to 83-II | 94.19 | 65.97 | 66.Ø5 | -Ø.Ø8 | 28.22 |

## Housing Quality (continued)

The simulations indicate that quality increased throughout the CHOSP period and remained virtually constant thereafter. Overall, the effect of CHOSP was to increase the level of housing quality by two per cent over the No CHOSP quality level. The interest rate effect on quality is positive for the first four quarters and negative thereafter. Recall (see section 4.3 above) that relative to the constant interest rate scenario, actual interest rates increased initially and then declined. The interest rate effect is very small compared to the CHOSP effect.

The findings on quality cannot be considered to be as reliable as the ownership findings since the data available for the econometrics were limited. Specifically, the quality variable was based on average floor space and the housing sample used to derive the data consisted only of NHA financed housing. As a consequence of the data limitations, only the qualitative results on quality should be considered to be reliable. Further empirical work would be needed in order to produce quantitatively reliable results.

**TABLE 5.2 QUALITY OF NEW OWNERSHIP HOUSING SIMULATION RUNS AND COMPARISONS**

| | Base Case (Run #1) | No CHOSP (Run #3) | No CHOSP & Constant Int. Rates (Run #4) | Total CHOSP Effect (Run 1-3) | Interest Rate Effect (Run 3-4) |
|---|---|---|---|---|---|
| 1980- IV | 1.Ø | 1.Ø | 1.Ø | Ø | Ø |
| 1981- I | Ø.983 | Ø.983 | Ø.983 | Ø | Ø |
| II | 1.Ø646 | 1.Ø646 | 1.Ø646 | Ø | Ø |
| III | 1.1599 | 1.1599 | 1.1599 | Ø | Ø |
| IV | 1.Ø355 | 1.Ø355 | 1.Ø355 | Ø | Ø |
| 1982- I | Ø.9882 | Ø.9882 | Ø.9882 | Ø | Ø |
| II | 1.Ø618 | 1.Ø618 | 1.Ø618 | Ø | Ø |
| III | 1.1365 | 1.1311 | 1.131 | Ø.ØØ54 | Ø.ØØØ1 |
| IV | 1.ØØ9 | Ø.9982 | Ø.9977 | Ø.Ø1Ø8 | Ø.ØØØ5 |
| 1983- I | Ø.9634 | Ø.9477 | Ø.9459 | Ø.Ø157 | Ø.ØØ18 |
| II | 1.Ø394 | 1.Ø185 | 1.Ø174 | Ø.Ø2Ø9 | Ø.ØØ11 |
| III | 1.1477 | 1.127 | 1.1271 | Ø.Ø2Ø7 | -Ø.ØØØ1 |
| IV | 1.Ø355 | 1.Ø141 | 1.Ø116 | Ø.Ø214 | -Ø.ØØ19 |
| 1984- I | Ø.9765 | Ø.9553 | Ø.9586 | Ø.Ø212 | -Ø.ØØ33 |
| II | 1.Ø762 | 1.Ø55 | 1.Ø582 | Ø.Ø212 | -Ø.ØØ32 |
| III | 1.143 | 1.122 | 1.1252 | Ø.Ø21 | -Ø.ØØ32 |
| IV | 1.Ø624 | 1.Ø4Ø9 | 1.Ø438 | Ø.Ø215 | -Ø.ØØ29 |

## 5.3 Effect of CHOSP on Rental Starts

A principal objective of CHOSP was to stimulate employment. Not only is the effect CHOSP had in terms of stimulating ownership starts relevant to that goal, but also any spillover effect on rental housing starts. Table 5.3 and Figure 5.1 compare rental starts for the three primary runs. The magnitude of the direct impact of CHOSP on ownership starts and the spillover effect on rental starts are compared in Table 5.4. The spillover effect reflects a shift in demand from the ownership to the rental sector. Table 5.5 shows the demand effect of CHOSP on the ownership and rental sectors. The spillover effect of CHOSP on rental housing starts results from the reduction in rental demand due to the shift in demand from the rental to the ownership sector.

As expected, the spillover effect of CHOSP on rental starts during the CHOSP period is in the opposite direction, but much smaller than the effect of CHOSP on ownership starts. In fact, the rental effect is so small (less than one per cent of the ownership effect) as to be negligible during the CHOSP period. The effect is slightly larger in the post-CHOSP period, but continues to be negative, since the rebound effect in the ownership sector is small enough to leave prices depressed in the ownership sector until the end of the simulation period. In other words, the speculative effect had not been totally offset by the end of 1984; hence, the effect of CHOSP on rental demand was still being felt. The effect on rental starts continues to increase after the termination of the CHOSP program, although it would be expected to decrease. That result appears to reflect the lag in the adjustment of the rental price to the shift in demand.

The interest rate effect on rental starts is much more significant than the CHOSP effect, but is also in the opposite direction to the impact on ownership starts. The dominant interest rate effect is the shift in demand from ownership to rental housing as interest rates fall. Combining ownership and rental starts (see Table 5.4), the effect of CHOSP on total starts is a 28,020 increase during the CHOSP period (increase ownership by 28,140 and decrease rental by 120) and a 13,280 increase for the period simulated (to 1984-IV).

For the period from 1982-III to 1984-IV, the decline in interest rates increased ownership starts by 92,700 units and decreased rental starts by 44,850 units for a net increase of 47,850 units.

**TABLE 5.3 RENTAL STARTS**
**ACTUAL AND SIMULATION RUNS**
**(000's of units)**

| | Base Case | No CHOSP | No CHOSP & Constant Int. Rates | Total CHOSP Effect | Interest Rate Effect |
|---|---|---|---|---|---|
| | (Run #1) | (Run #3) | (Run #4) | (Run 1-3) | (Run 3-4) |
| 1981- I | 7.7Ø | 7.7Ø | 7.7Ø | Ø | Ø |
| II | 14.7 | 14.7 | 14.7 | Ø | Ø |
| III | 15.37 | 15.37 | 15.37 | Ø | Ø |
| IV | 16.76 | 16.76 | 16.76 | Ø | Ø |
| 1982- I | 1Ø.77 | 1Ø.77 | 1Ø.77 | Ø | Ø |
| II | 13.93 | 13.93 | 13.93 | Ø | Ø |
| III | 13.23 | 13.23 | 12.48 | Ø | Ø.75 |
| IV | 15.1 | 15.11 | 13.93 | -Ø.Ø1 | 1.18 |
| 1983- I | 8.55 | 8.59 | 9.73 | -Ø.Ø4 | -1.14 |
| II | 12.73 | 12.8 | 17.Ø6 | -Ø.Ø7 | -4.26 |
| III | 13.26 | 13.38 | 19.19 | -Ø.12 | -5.81 |
| IV | 13.37 | 13.55 | 19.29 | -Ø.18 | -5.74 |
| 1984- I | 6.54 | 6.78 | 13.33 | -Ø.24 | -6.55 |
| II | 1Ø.83 | 11.13 | 18.77 | -Ø.3Ø | -7.64 |
| III | 1Ø.Ø4 | 1Ø.39 | 19.17 | -Ø.35 | -8.78 |
| IV | 13.63 | 14.Ø4 | 2Ø.9 | -Ø.41 | -6.86 |
| 1981 | 54.53 | 54.53 | 54.53 | Ø | Ø |
| 1982 | 53.Ø3 | 53.Ø4 | 51.11 | -Ø.Ø1 | 1.93 |
| 1983 | 47.91 | 48.32 | 65.27 | -Ø.41 | -16.95 |
| 1984 | 41.Ø4 | 42.34 | 72.17 | -1.3 | -29.83 |
| 1981-84 | 196.51 | 198.23 | 243.Ø8 | -1.72 | -44.85 |
| 1982-III to 83-II | 49.61 | 49.73 | 53.2 | -Ø.12 | -3.47 |

# FIG. 5.1 – RENTAL STARTS

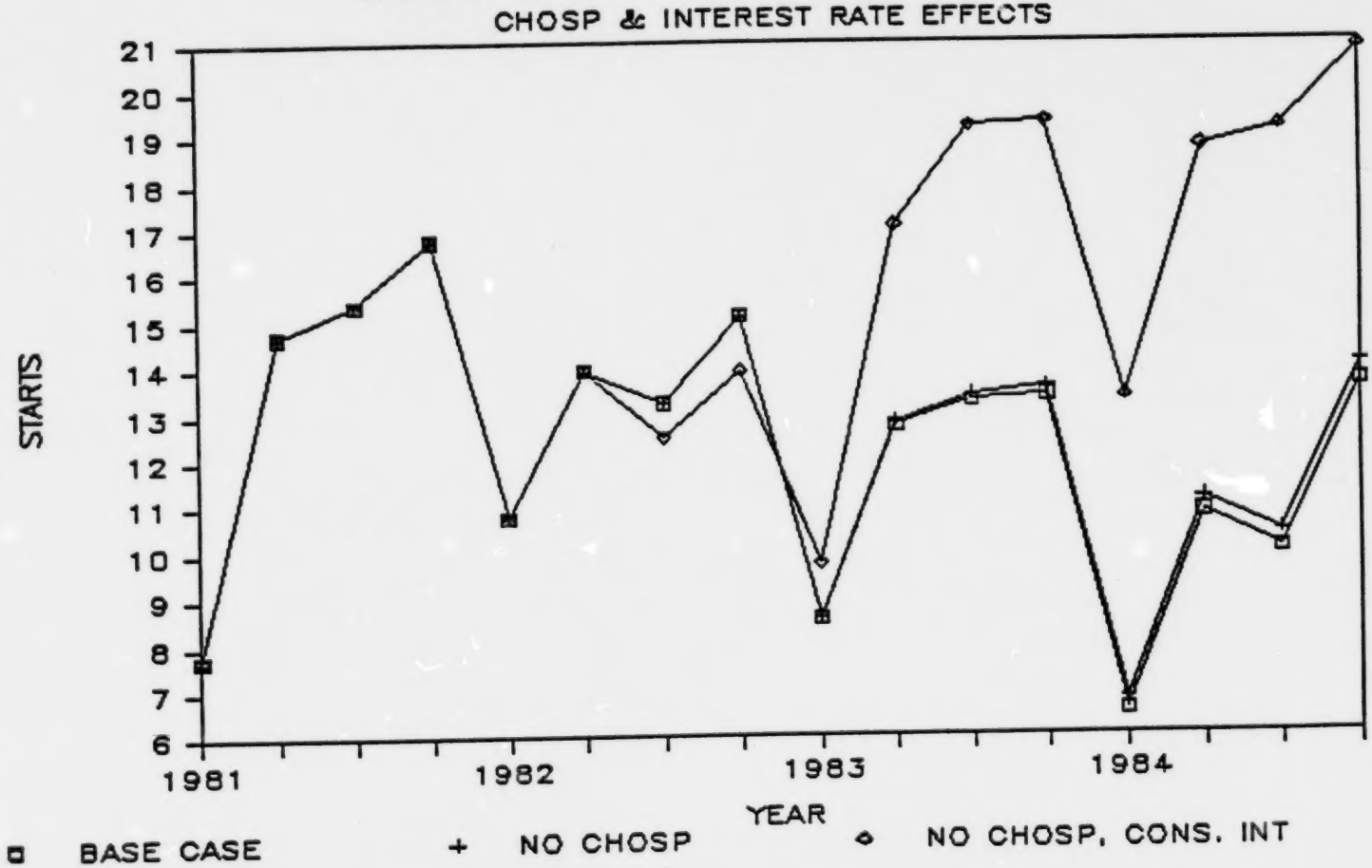


**TABLE 5.4 EFFECT OF CHOSP AND INTEREST RATES ON OWNERSHIP AND RENTAL STARTS**
**(000's of units)**

| | OWNERSHIP | | RENTAL | | TOTAL | |
|---|---|---|---|---|---|---|
| | Total CHOSP Effect | Interest Rate Effect | Total CHOSP Effect | Interest Rate Effect | Total CHOSP Effect | Interest Rate Effect |
| | (Run 1-3) | (Run 3-4) | (Run 1-3) | (Run 3-4) | | |
| 1981- I | Ø | Ø | Ø | Ø | Ø | Ø |
| II | Ø | Ø | Ø | Ø | Ø | Ø |
| III | Ø | Ø | Ø | Ø | Ø | Ø |
| IV | Ø | Ø | Ø | Ø | Ø | Ø |
| 1982- I | Ø | Ø | Ø | Ø | Ø | Ø |
| II | Ø | Ø | Ø | Ø | Ø | Ø |
| III | 7.87 | -1.41 | Ø | Ø.75 | 7.87 | -Ø.66 |
| IV | 7.27 | -1.75 | -Ø.Ø1 | 1.18 | 7.26 | -Ø.57 |
| 1983- I | 6.74 | 3.4 | -Ø.Ø4 | -1.14 | 6.7 | 2.26 |
| II | 6.26 | 11.12 | -Ø.Ø7 | -4.26 | 6.19 | 6.86 |
| III | -2.12 | 13.7 | -Ø.12 | -5.81 | -2.24 | 7.89 |
| IV | -2.19 | 12.73 | -Ø.18 | -5.74 | -2.37 | 6.99 |
| 1984- I | -2.2 | 13.Ø9 | -Ø.24 | -6.55 | -2.44 | 6.54 |
| II | -2.19 | 14.5 | -Ø.3 | -7.64 | -2.49 | 6.86 |
| III | -2.22 | 16.27 | -Ø.35 | -8.78 | -2.57 | 7.49 |
| IV | -2.22 | 11.Ø5 | -Ø.41 | -6.86 | -2.63 | 4.19 |
| 1981 | Ø | Ø | Ø | Ø | Ø | Ø |
| 1982 | 15.14 | -3.16 | -Ø.Ø1 | 1.93 | 15.13 | -1.23 |
| 1983 | 8.69 | 4Ø.95 | -Ø.41 | -16.95 | 8.28 | 24 |
| 1984 | -8.83 | 54.91 | -1.3 | -29.83 | -1Ø.13 | 25.Ø8 |
| 1981-84 | 15 | 92.7 | -1.72 | -44.85 | 13.28 | 47.85 |
| 1982-III to 83-II | 28.14 | 11.36 | -Ø.12 | -3.47 | 28.Ø2 | 7.89 |

**TABLE 5.5 CHOSP AND INTEREST RATE EFFECTS ON OWNERSHIP AND RENTAL DEMAND**
(000's of households)

| | OWNERSHIP | | RENTAL | |
|---|---|---|---|---|
| | Total CHOSP Effect (Run 1-3) | Interest Rate Effect (Run 3-4) | Total CHOSP Effect (Run 1-3) | Interest Rate Effect (Run 3-4) |
| 1981- I | 0 | 0 | 0 | 0 |
| II | 0 | 0 | 0 | 0 |
| III | 0 | 0 | 0 | 0 |
| IV | 0 | 0 | 0 | 0 |
| 1982- I | 0 | 0 | 0 | 0 |
| II | 42.8 | 0 | 0 | 0 |
| III | 50.8 | -0.4 | -7.6 | 0.4 |
| IV | 58.1 | -68.3 | -14.7 | 86.2 |
| 1983- I | 64.3 | 13.2 | -20.9 | 24.6 |
| II | 28.2 | 32.6 | -26.7 | 1.7 |
| III | 27 | 109.5 | -25.6 | -67.4 |
| IV | 25.8 | 159.2 | -24.5 | -114.4 |
| 1984- I | 24.7 | 171.4 | -23.3 | -113.4 |
| II | 23.4 | 197.4 | -22.1 | -145.3 |
| III | 22.2 | 173.8 | -21 | -144.3 |
| IV | 21 | 131.3 | -19.8 | -98.6 |

## 5.4 Actual versus Simulated Starts

Table 4.1 included both the Base Case and actual ownership housing starts. Those runs also are graphically presented in Figure 5.2. The predictive ability of the model is tested by a comparison of the Base Case to the actuals. The predictive power of the static model can be tested in the same manner. Table 5.6 presents the differences between both the Base Case (dynamic simulation using actual actual interest rates with CHOSP grants available) and actual ownership starts, and the estimated starts using the ownership starts equation alone and actual starts. Root mean square errors for both projection are provided below.

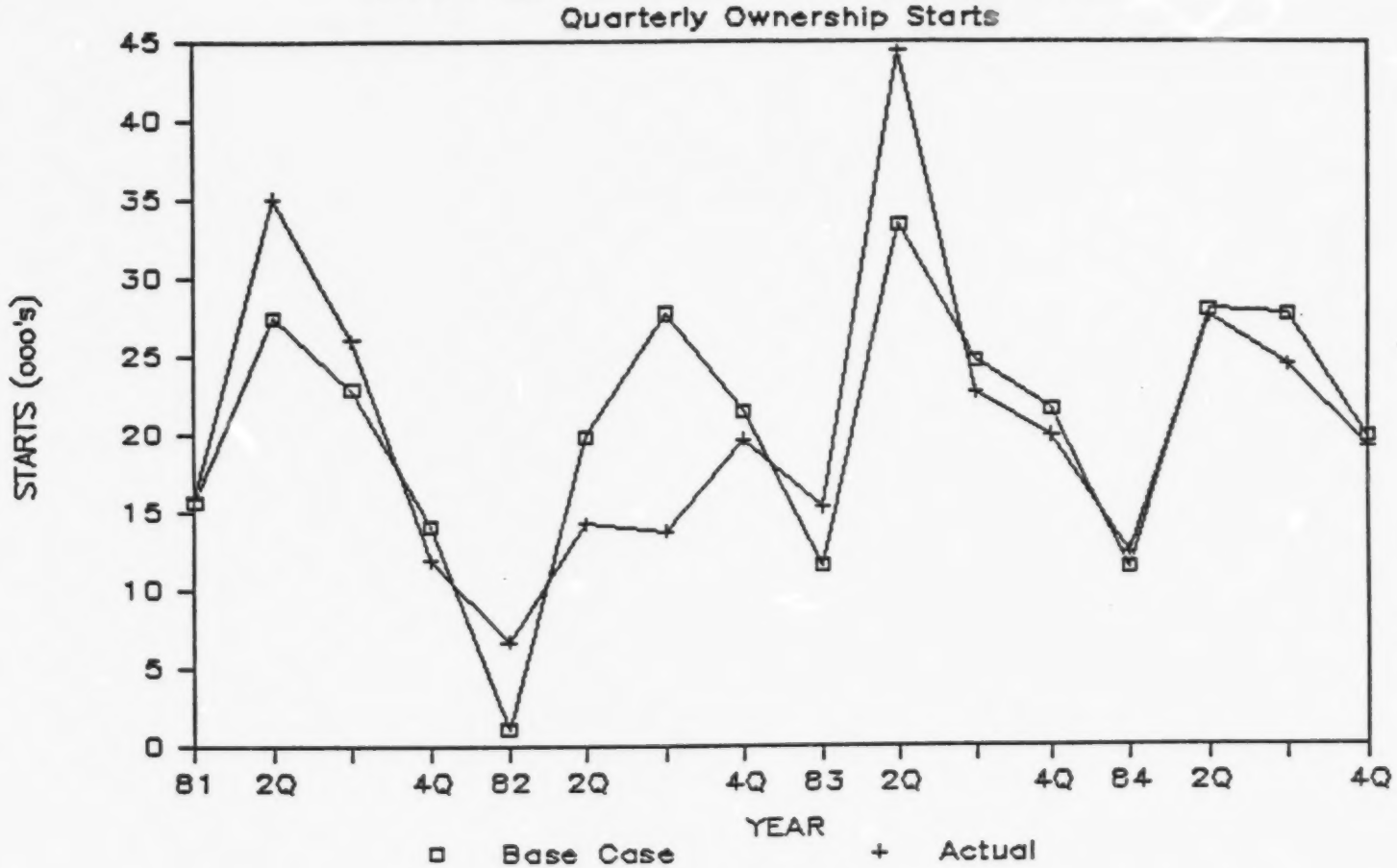
| Root Mean Squared Error of: | Simulation Model | Starts Equation |
|---|---|---|
| 1981-I to 1982-II | 4.735 | 4.425 |
| 1982-III to 1983-II | 9.123 | 8.040 |
| 1983-III to 1984-IV | 1.811 | 2.635 |
| 1981-I to 1984-IV | 5.518 | 5.110 |

The root mean square errors (RMSE) of the simulation model and the starts equation alone are fairly close in value, with the RMSE of the starts equation being slightly better over the full sixteen quarters studied. Both were relatively inaccurate during the CHOSP-period (1982-III to 1983-II), presumably because both assumed a constant CHOSP effect rather than one which increased as the termination date of the program approached. The dynamic model was more accurate than the starts equation alone in the post-CHOSP period.

**TABLE 5.6 COMPARISON OF ACTUAL STARTS TO THE STATIC AND DYNAMIC ANALYSIS**
**(000's of units)**

| | Actual Starts | Base Case (Run #1) | Actual Minus Base Case | Estimated | Actual Minus Estimated |
|---|---|---|---|---|---|
| 1981- I | 15.964 | 15.69 | Ø.274 | 14.55Ø | 1.414 |
| II | 35.113 | 27.5 | 7.613 | 28.7Ø5 | 6.4Ø8 |
| III | 26.Ø29 | 22.92 | 3.1Ø9 | 25.Ø84 | Ø.945 |
| IV | 11.965 | 14.14 | -2.175 | 12.384 | -Ø.419 |
| 1982- I | 6.697 | 1.14 | 5.557 | 3.434 | 3.263 |
| II | 14.272 | 19.86 | -5.588 | 22.19Ø | -7.918 |
| III | 13.792 | 27.7 | -13.9Ø8 | 25.842 | -12.Ø5Ø |
| IV | 19.696 | 21.51 | -1.814 | 19.395 | Ø.3Ø1 |
| 1983- I | 15.373 | 11.57 | 3.8Ø3 | 14.198 | 1.175 |
| II | 44.442 | 33.41 | 11.Ø32 | 33.862 | 1Ø.58Ø |
| III | 22.643 | 24.76 | -2.117 | 24.263 | -1.62Ø |
| IV | 19.927 | 21.66 | -1.733 | 2Ø.Ø78 | -Ø.151 |
| 1984- I | 12.488 | 11.43 | 1.Ø58 | 1Ø.2Ø9 | 2.279 |
| II | 27.527 | 27.96 | -Ø.433 | 29.911 | -2.384 |
| III | 24.432 | 27.68 | -3.248 | 25.172 | -Ø.74Ø |
| IV | 19.2Ø4 | 19.79 | -Ø.586 | 13.95Ø | 5.254 |
| 1981 | 89.Ø71 | 8Ø.25 | 8.821 | 8Ø.722 | 8.349 |
| 1982 | 54.457 | 7Ø.21 | -15.753 | 7Ø.862 | -16.4Ø5 |
| 1983 | 1Ø2.385 | 91.4 | 1Ø.985 | 92.4Ø1 | 9.984 |
| 1984 | 83.651 | 86.86 | -3.2Ø9 | 79.242 | 4.4Ø9 |
| 1981-84 | 329.564 | 328.72 | Ø.844 | 323.227 | 6.337 |
| 1982-III to 83-II | 93.3Ø3 | 94.19 | -Ø.887 | 93.298 | Ø.ØØ5 |

# 5.2: ACTUAL vs BASE CASE



# 6.0 SUMMARY AND CONCLUSIONS

In this project, a model of the Canadian housing market was formulated and the following hypotheses were tested:

- CHOSP and lower interest rates combined to unleash pent-up demand for new housing accumulated during previous periods of high interest rates;

- CHOSP had a net, quantifiable impact on housing starts over the program period in addition to the influence of other factors affecting housing starts;

- CHOSP "brought forward" future demand for new housing starts, thereby reducing housing starts in subsequent period.

A system dynamics model was developed to simulate ownership and rental supply, demand and price. Eight of the model's key equations were estimated econometrically. In addition, the estimated ownership housing starts equation was used to derive a static estimate of the impact of CHOSP.

The impact of CHOSP and lower interest rates combined, as estimated by the system dynamics model, was 39,500 units during the CHOSP period (1982-III to 1983-IV, inclusive) or almost 10,000 units per quarter. Separating the impacts of the two variables, CHOSP accounted for 28,140 units and lower interest rates accounted for 11,360 starts during the CHOSP period. The interest rate effect was felt almost entirely in the last quarter of the CHOSP period.

The static model estimate of the impact of CHOSP indicated a somewhat higher impact on starts. Two specifications of the starts equation were estimated, one with the CHOSP dummy variable lagged, the other with no lag. With no lag, the estimated CHOSP impact was almost 32,500 units (8,100 per quarter). With the CHOSP variable lagged, the estimated CHOSP impact was close to 37,000 units (9,200 per quarter).

The magnitude of the rebound effect which measures the extent to which CHOSP brought forward housing starts was small relative to the CHOSP effect. The decline in starts in the six quarters after the program was terminated equalled 2,200 units per quarter. The same effect also was estimated by adding a post-CHOSP dummy variable to the static model. The estimated coefficient (which was not statistically significant) showed that starts declined by just over 1000 units per quarter.

An examination of the rebound effect also was undertaken by running simulations to isolate the equilibrium and speculative effects of CHOSP. The equilibrium effect represents the extent to which ownership starts would have increased if the CHOSP subsidy were expected to be permanent. The speculative effect represents the portion of the increase which can be attributed to buyers taking advantage of the CHOSP program by jumping into the market sooner than they would have if the program had been expected to be permanent. The equilibrium effect was estimated to be negligible; the

speculative effect was substantial. Virtually all of the increase during the CHOSP period appears to have been brought forward by the program. However, since the rebound effect is small, it appears that demand was brought forward from a period of several years following the termination of the program.

Although the data were limited, an estimate of the effect of CHOSP on quality was derived. Using the dynamic model, the increase in the quality of new housing was estimated to be approximately two percent.

The spillover effect on rental starts also was estimated using the dynamic model. That effect was found to be negligible; hence, the net effect of CHOSP on starts is 28,000 units during the CHOSP period.

The analysis indicates that a temporary grant program such as CHOSP is effective in stimulating construction activity in the housing industry. However, the effect consists almost entirely of bringing demand forward from later periods to the program time period. The decline in starts in later periods almost completely offsets the gains realised during the period covered by the program, although the rebound effect is spread over several years. As a result, CHOSP appears to have served as a stabilisation program which smoothed housing construction activity by accelerating starts in the half year before declining interest rates stimulated housing activity.

## POSSIBLE EXTENSIONS OF THE MODEL

This project had a limited objective: to evaluate the effect of CHOSP on housing starts. The model, however, has the potential of being applied much more broadly. Some suggested applications are:

i. evaluate other housing incentive schemes retrospectively,

ii. project the effect of alternative housing policies which are being considered for the future,

iii. examine how the effectiveness of different housing policies may be altered by different conditions in the housing market, the financial markets and in the economy generally,

iv. examine how a combination of federal, provincial and municipal housing policies interact to complement or counteract each other.

A number of further developments to the model would make it more flexible and more useful for the policy applications noted above. Some possible extensions are:

1. The model could be replicated for specific regional markets, such as provinces, or municipalities.

ii. Adequate data were not available for estimating certain relationships, such as conversions and demolitions; hence, specific studies supported by data collection of those relationships would improve the model.

iii. Stratification of the market by type of housing would be desirable since the changing mix of housing (size of units, size of complexes, price range, etc.) may be as important for policy development as overall market trends in starts, conversions, demand, etc.

iv. An existing macroeconomic model could be used to determine the effect of increased residential construction on employment. A detailed housing model interfaced with a macromodel would serve as a powerful program planning and analysis tool.

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# APPENDIX A

## DOCUMENTATION OF THE MODEL

## APPENDIX A - DOCUMENTATION OF THE MODEL

In this Appendix the model is described in detail. The description proceeds through the *DYNAMO* program section by section (a full listing of the program appears at the end of the Appendix). Each section of the program is a group of related equations which define a key variable such as ownership demand or rental price. The sections are clearly identified in the *DYNAMO* program.

The discussion which follows explains the overall structure of the model, the specification of key equations, and the empirical basis of the parameter values which were not estimated by formal econometric analysis. The econometric results of the eight estimated equations are presented in Appendix C; hence, only the rationale for the specification used and the final results are reported in this Appendix. For details on the data used, and full statistical reporting of the results, see Appendix C.

### JOB CONTROL LANGUAGE (JCL)

Preceding the model itself are several lines of JCL which are used for submitting jobs to the University of Toronto computer system. They do not relate to this model specifically, but instruct the computer regarding the hardware and software to be used. Similar JCL would be required to run the program on other systems. Refer to the *DYNAMO Users Manual*. The JCL statements are:

```
//JDTJOB JOB (TY,9272,IKWK),'TODD'
/*JOBPARM L=10,NOLOG
/*ROUTE PRINT UTORONTO.JTODD
// EXEC DYNAMO,PARM='BATCH,PCL=12,PLW=65'
//BASIC DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL2 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL3 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL4 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL5 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//DYNA.SYSIN DD *
```

### OVERALL STRUCTURE OF THE PROGRAM

The model consists of two sectors: ownership and rental. Within each sector, equations are grouped into four components: supply, quality of new stock, demand and price. In addition, there are several segments of the model which specify initialising values, exogenous data, and specify the desired output.

The discussion of the model is divided into four parts: (1) ownership sector, (2) rental sector, (3) data and output specification, and (4) rerun specifications.

## 1. THE OWNERSHIP SECTOR

### 1.1 OWNERSHIP SUPPLY (ON)

Ownership supply represents the stock of ownership units available for occupancy. Four variables are assumead to affect this quantity:

- completions of new units (OHC),
- demolitions of existing units (OD),
- transfers (conversions) of ownership to rental units (OT), and
- transfers (conversions) of rental to ownership units (RT).

Each of the above variables is determined by an equation which indicates the rate at which that variable increases or decreases the available stock. Those rates change continuously in response to price incentives.

Completions are determined by starts with a delay given by the ***DYNAMO*** "DELAYP" function. That form of delay function calculates the number of units under construction, indicating the magnitude of the delay. Starts, in turn, are a function of three variables: (i) the ratio of the price of ownership units to construction costs (OP/CC), (ii) the difference between the nominal mortgage and bond rates (MRMBRM1), and (iii) the real mortgage rate (RMR). Also, dummy variables are entered for seasonal variations in the rate of housing starts (S1, S2, S3) and for the effect of CHOSP.

The coefficients for the starts equation are based on an econometric estimate of the ownership starts equation which is reported in Appendix C. Two adjustments had to be made to the parameter estimates before using them in the dynamic model. First, the econometric analysis uses quarterly data. Therefore, the parameters have been multiplied by a factor of 4 to convert the equation to annual housing starts, the specification required for the model. Second, the intercept and seasonal variables are reestimated to correct the model's seasonality. That is necessary since many of the relationships in the model other than starts have seasonal variations which are not separately incorporated into the model.

The parameter estimates for the starts equation using quarterly data, the annualized coefficients and the adjusted coefficients are:

| Variable | | SAS Estimate | Annualized Coefficient | Adjusted Coefficient |
|---|---|---|---|---|
| INTERCEPT | = | 4.128 | 16.515 | 6.33 |
| S1 | = | -11.226 | -44.906 | -41.5 |
| S2 | = | 3.946 | 15.786 | 19.84 |
| S3 | = | 4.153 | 16.611 | 10.63 |
| OP/CC | = | 28.761 | 115.044 | 115.04 |
| MRMBRM1 | = | -369.63 | -1478.5 | -1478.5 |
| RMR | = | -81.62 | -326.48 | -326.5 |
| CHOSP | = | 8.11 | 32.42 | 32.42 |

The CHOSP term appears in the starts equation of the model as a policy variable, which means that it is non-zero only in simulations in which the CHOSP program is active. It was included in the econometric analysis to remove its effect in estimating the starts equation for the model.

The rate of demolitions is determined by the ratio of ownership prices to the GNE deflator (OP/GNED) which is the real ownership price. The normalized demolition rate is Ø.4 per cent per annum. Conversions from ownership to rental are determined by the ratio of the price indexes for rental and ownership units (RP/OP), with a normalized value of 2 per cent. These values were derived from the implicit loss rates rates for single-detached and apartment units when intercensal completions were added to the 1976 census stocks and the resulting values compared to the 1981 census stocks. The relationships were not estimated econometrically due to lack of data.

In the model, all supply related variables are in thousands of units. The OHSACC (accumulated ownership housing starts) equation, which appears in the sector of the model listed below, is included simply to keep track of the cumulative starts. The *DYNAMO* equations which make up the supply component of the ownership sector are:

```
L    ON.K=ON.J+DT*(OHC.JK-OD.JK-OT.JK+RT.JK)
R    OHC.KL=DELAYP(OHS.K,OHSDEL,OHUC.K)
A    OHS.K=THTAØ+THTA1*S1.K+THTA2*S2.K+THTA3*S3.K+
X        THTA4*(OP.K/CC.K)+THTA5*MRMBRM1.K+THTA6*RMRM1.K+
X        POLCHOSP*SPECDEM*CHOSP.K
C            THTAØ=6.33
C            THTA1=-41.5
C            THTA2=19.84
C            THTA3=1Ø.63
C            THTA4=115.Ø4
C            THTA5=-1478.5
C            THTA6=-326.5
C            SPECDEM=32.42

R    OD.KL=MAX(ODF.K*ON.K,Ø)
A    ODF.K=ODFC*(2-(OP.K/GNED.K))
C            ODFC=Ø.ØØ4

R    OT.KL=MAX(OTF.K*ON.K,Ø)
A    OTF.K=OTFC*(1+(RP.K/OP.K))
C            OTFC=Ø.Ø1

L    OHSACC.K=OHSACC.J+DT*OHS.J
N    OHSACC=Ø.Ø
```

## 1.2 OWNERSHIP DEMAND (OH)

The quantity of housing demanded at any point in time equals the number of households seeking accommodation. Consequently, modelling aggregate housing demand is equivalent to modelling the household formation process. The primary determinant of household formation is population, but economic factors and the population's age distribution are also important.

Demand represents the number of housing units that would be occupied in the absence of supply constraints. The actual number of units occupied may fall short of demand since household formation will be deterred under

tight market conditions since suitable housing may be difficult for some households to find. That feature of the market can be interpreted as a transaction cost effect. As the market becomes tighter, transaction costs increase thereby increasing the effective cost of housing. Transaction costs are not included in the model, therefore, it is expected that the coefficient on demand (number of occupied units) may be biased upward when vacancies are low.

In the demand equation the OHH term represents "normalized ownership demand" which equals the number of households as calculated assuming Statistics Canada's population estimates by age and sex (intermediate migration and fertility assumptions) and constant ownership headship rates, based on the 1981 Census. The latter term captures the effects of growth in population and the change in the age distribution of that population, but it does not reflect changes in the economic determinants of headship rates. Normalized ownership demand is translated into actual demand by multiplying it by the per normalized household demand term which is econometrically estimated. The latter term captures the effect of several economic variables. The OSF term is used to initialize the equation.

Demand per normalized household is an estimated relationship using five independent variables: (1) household income (RY), (2) the ratio of the effective ownership price (net of the CHOSP grant when relevant) and the rental price (ADJOP/RP), (3) the inflation rate (INFLR), and (4) the difference between the mortgage and bond rates (MRMBR), and (5) the real mortgage rate (RMR).

Finally, a term is included in the demand sector for speculative demand (SPECDEM). It is the same term as appears in the supply sector, implying that supply and demand are affected equally by speculative effect of CHOSP. It is activated only when POLCHOSP=1 indicating that the CHOSP policy is assumed in the run and CHOSP=1 which is true only during the CHOSP period. The value of the SPECDEM term is based on the starts effect estimated for the ownership starts equation. The *DYNAMO* equations which make up the ownership demand sector are:

```
A   OH.K=(OHH.K*OSF*(A0+A1*RY.K+A2*(ADJOP.K/RP.K)+
X     A3*INFLR.K+A4*MRMBR.K+A5*RMR.K))+POLCHOSP*SPECDEM*CHOSP.K
C           A0=0.9310
C           A1=0.00063185
C           A2=-0.07134
C           A3=0.7318
C           A4=-0.8255
C           A5=0.5542
C           OSF=1.01192
```

**1.3 OWNERSHIP PRICE (OP)**

The ownership price index changes at a rate determined by the OPR equation. The value of OPR changes continuously (for all runs reported in this paper, values are recalculated 20 times per year). The price index equals 1.0 at the beginning of the simulation runs (beginning of the first quarter of 1981).

The rate of price change equation has been estimated, with price change as a function of (1) the vacancy rate (OVR), (2) the inflation rate (INFLR), (3) the change in the real mortgage rate (RMRCH), and (4) the CHOSP dummy variable. The vacancy rate term used is:

$$(NOVR - OVR)/OVR \qquad (1)$$

where

NOVR is the normal vacancy rate (assumed to equal 3 per cent), and
OVR is the actual vacancy rate.

The actual vacancy rate is calculated as the ownership supply (ON) minus the demand (OH), all divided by the supply. As noted earlier, the demand calculation does not take into account availability constraints; hence, it may exceed supply. Consequently, the *DYNAMO* functions MIN and FIFGE are used to avoid mechanical problem which may arise if the OVR term becomes too small, making the vacancy rate term (1) above unrealistically large. This potential problem arises since the vacancy rate term in the price change equation is non-linear. The *DYNAMO* equations which make up the ownership price sector are:

```
L   OP.K=OP.J+DT*OPR.JK
R   OPR.KL=OP.K*(BETA0+BETA1*MIN(5,((NOVR-OVR.K)/
X         FIFGE(OVR.K,-OVR.K,OVR.K,0)))+
X         BETA2*INFLR.K+BETA3*RMRCH.K+BETA4*POLCHOSP*CHOSP.K)
C           BETA0=-0.016056
C           BETA1=0.004126
C           BETA2=0.636435
C           BETA3=0.056428
C           BETA4=-0.07644

A   OVR.K=((ON.K-OH.K)/ON.K)*100
C           NOVR=3.0
```

## 1.4 QUALITY OF NEW OWNERSHIP HOUSING (OQ)

The quality index, which was econometrically estimated, reflects the average liveable floor area of single-detached housing financed under the NHA. The estimated relationship is used directly in the model, with quality being a function of (i) the ratio of ownership price to the GNE deflator (OP/GNED), and (ii) real income (RY). The term OQSF normalizes the index, setting it equal to 1.0 at the end of the fourth quarter of 1980. The *DYNAMO* equations for the quality of ownership housing segment of the model are:

```
A   OQ.K=(PI0+PI1*(OP.K/GNED.K)+PI2*RY.K)/OQSF
C           PI0=33.411
C           PI1=-28.38
C           PI2=15.727
C           OQSF=101.48
```

## 2. THE RENTAL SECTOR

### 2.1 RENTAL SUPPLY (RN)

The rental supply sector is similar to the ownership supply sector described above. The stock of rental units is changed by completions (RHC), demolitions (RD), transfers (conversions) of ownership to rental units (OT), and transfers of rental to ownership units (RT). Each of those terms is determined by an equation that corresponds to the analogous ownership equation.

Completions are related to starts by a delay, with the rental starts equation being based on the estimated equation reported in Appendix C. The parameter estimates using quarterly data, the annualized coefficients and the adjusted coefficients are:

| Variable | | SAS Estimate | Annualized Coefficient | Adjusted Coefficient |
|---|---|---|---|---|
| INTERCEPT | = | -64.745 | -258.98 | -258.76 |
| S1 | = | -7.843 | -31.374 | -29.7 |
| S2 | = | -1.141 | -4.563 | -7.94 |
| S3 | = | Ø.214 | Ø.856 | -4.81 |
| OP/GNED | = | 18.47Ø | 73.88 | 73.88 |
| CC/GNED | = | 6Ø.375 | 241.5Ø | 241.5Ø |
| MRMBRM1 | = | 194.564 | 778.26 | 778.26 |
| RMR | = | 1Ø.371 | 41.484 | 41.484 |

The same two adjustments had to be made to these parameter estimates as were made to the parameter estimates for ownership starts. The CHOSP term does not appear in the rental starts equation of the model. CHOSP grants were only available for single units, even if a multiple unit dwelling were purchased; hence, it there was no attempt to look for a CHOSP effect on rental starts.

As in the ownership sector, the variables in the rental supply sector are in thousands of units. The RHSACC term is included to keep track of the cumulative starts. The equations which make up the supply component of the rental sector are:

```
L   RN.K=RN.J+DT*(RHC.JK-RD.JK+OT.JK-RT.JK)
R   RHC.KL=DELAYP(RHS.JK,RHSDEL,RHUC.K)
A   RHS.K=TAUØ+TAU1*S1.K+TAU2*S2.K+TAU3*S3.K+
X       TAU4*(RP.K/GNED.K)+TAU5*(CC.K/GNED.K)+
X       TAU6*MRMBRM1.K+TAU7*RMRM1.K
C           TAUØ=-258.76
C           TAU1=-29.7
C           TAU2=-7.94
C           TAU3=-4.81
C           TAU4=73.88
C           TAU5=241.5
C           TAU6=778.26
C           TAU7=41.484
```

```
R    RD.KL=MAX(RDF.K*RN.K,Ø)
A    RDF.K=RDFC*(2-(RP.K/GNED.K))
C          RDFC=Ø.ØØ4

R    RT.KL=MAX(RTF.K*RN.K,Ø)
A    RTF.K=RTFC*(1+(OP.K/RP.K))
C          RTFC=Ø.Ø15

L    RHSACC.K=RHSACC.J+DT*RHS.J
N    RHSACC=Ø.Ø
```

## 2.2 RENTAL DEMAND (RH)

The rental demand sector parallels the ownership demand sector, except that there is no CHOSP term in the demand equation. Normalized ownership demand (RHH) is exogenously determined from Statistics Canada population projections at the 1981 Census rental headship rates. The latter term is multiplied by the estimated function for per normalized household demand, which itself is a function of the five independent variables corresponding to those appearing in the ownership demand sector: (1) household income (RY), (2) the ratio of the ownership price index and the rental price (OP/RP), (3) the inflation rate (INFLR), and (4) the difference between the mortgage and bond rates (MRMBR), and (5)the real mortgage rate (RMR). The *DYNAMO* equations which make up the rental demand sector are:

```
A    RH.K=RHH.K*RSF*(BØ+B1*RY.K+B2*(OP.K/RP.K)+B3*INFLR.K+
X      B4*MRMBR.K+B5*RMR.K)
C          BØ=1.ØØ7596
C          B1=Ø.ØØ1625
C          B2=Ø.11345
C          B3=-Ø.91645
C          B4=Ø.9849
C          B5=-Ø.92289
C          RSF=Ø.991Ø7
```

## 2.3 RENTAL PRICE (RP)

The rental price sector also is similar to the ownership price sector. The rate of change in the rental price index is determined by an estimated equation, with the proportional change being a function of (1) the normal vacancy rate minus the actual vacancy rate (NVR-VR), (2) the inflation rate (INFLR), and (3) the real mortgage rate (RMR4Q).

The actual vacancy rate equals the rental supply (RN) minus the demand (RH), divided by the supply. The adjustments used in the ownership sector are not required in the rental sector since the vacancy rate term is linear in the rental sector. The *DYNAMO* equations which make up the rental price sector are:

```
L   RP.K=RP.J+DT*RR.JK
R   RR.KL=RP.K*(ALPHAØ+ALPHA1*INFLR.K+ALPHA2*(NVR-VR.K)+
X     ALPHA3*RMR4Q.K)
C           ALPHAØ=-Ø.Ø1588
C           ALPHA1=Ø.36726
C           ALPHA2=Ø.Ø1287
C           ALPHA3=Ø.45882

A   VR.K=((RN.K-RH.K)/(RN.K))*1ØØ
C           NVR=4.Ø
```

## 3. DATA AND OUTPUT

The remaining equations of the model specify exogenously determined variables and constants used by the model, policy variables which set conditions for each run, and parameters which control the execution of the simulations. They are described briefly below.

### 3.1 EXOGENOUS VARIABLES

A number of variables used in the model are exogenous. The data used are the same as were used for the econometric analysis and are described in Appendix C. The exogenous variables include:

- household income (RY),
- construction costs (CC),
- the inflation rate, current and lagged (INFLR, INFLRM1),
- the GNE deflator (GNED),
- the real mortgage rate, four quarter average and four quarter change (RMR4Q, RMRCH),
- the nominal mortgage rate, current and lagged (NMR, NMRM1),
- the difference between the mortgage and bond rates, actual and lagged (MRMBR, MRMBRM1), and
- the ownership and rental normalized demand (OHH, RHH).

```
A     RY.K=TABLE(TRY,TIME,TSTR,TEND,QUART)
T      TRY=6.132829/5.996729/6.526216/7.Ø87641/6.311Ø76/
X       5.974495/6.469802/6.878981/6.ØØ4359/5.687665/6.193829/
X       6.882674/6.138344/5.751281/6.45Ø998/6.853831/6.298364

A     CC.K=TABLE(TCC,TIME,TSTR,TEND,QUART)
T      TCC=1.ØØØØ/1.Ø279/1.Ø885/1.Ø776/1.Ø828/
X       1.Ø894/1.1282/1.1425/1.1722/1.2Ø14/1.282Ø/
X       1.25Ø2/1.2554/1.282Ø/1.272Ø/1.2738/1.2921

A     INFLR.K=TABLE(TINFLR,TIME,TSTR,TEND,QUART)
T     TINFLR=Ø.1Ø68/Ø.1Ø98/Ø.Ø897/Ø.1123/Ø.1Ø93/
X        Ø.1133/Ø.1Ø92/Ø.Ø922/Ø.1Ø25/Ø.Ø782/Ø.Ø644/
X        Ø.Ø495/Ø.Ø283/Ø.Ø349/Ø.Ø352/Ø.Ø228/Ø.Ø29Ø
```

```
A     INFLRM1.K=TABLE(TINFLRM1,TIME,TSTR,TEND,QUART)
T     TINFLRM1=0.1107/0.1068/0.1098/0.0897/0.1123/
X        0.1093/0.1133/0.1092/0.0922/0.1025/0.0782/
X        0.0644/0.0495/0.0283/0.0349/0.0352/0.0228

A     GNED.K=TABLE(TGNED,TIME,TSTR,TEND,QUART)
T      TGNED=1.0000/1.0348/1.0564/1.1183/1.1093/
X        1.1528/1.1718/1.2214/1.2230/1.2421/1.2473/
X        1.2818/1.2576/1.2854/1.2912/1.3110/1.2941

A     RMR4Q.K=TABLE(TRMR4Q,TIME,TSTR,TEND,QUART)
T     TRMR4Q=0.002861/0.02703/0.05002/0.03734/0.05785/
X        0.06262/0.07430/0.09374/0.07803/0.09306/0.09331/
X        0.09362/0.10166/0.08841/0.08559/0.10163/0.09849

A     RMRCH.K=(RMR.K-RMRM1.K)/RMRM1.K
A     RMR.K=FIFGE(.08844,((1+NMR.K)/(1+INFLR.K))-1,TIME.K,SWTM)
A     RMRM1.K=FIFGE(.08844,((1+NMRM1.K)/(1+INFLRM1.K))-1,
X        TIME.K,SWTM+0.25)

A     MRMBR.K=TABLE(TMRMBR,TIME,TSTR,TEND,QUART)
T     TMRMBR=0.0121/0.0086/0.0191/0.0336/0.0325/
X        0.018/0.0239/0.03/0.0149/-0.0003/0.0033/
X        -0.0026/-0.0042/-0.015/-0.0091/0.0092/0.005

A     MRMBRM1.K=TABLE(TMRMBRM1,TIME,TSTR,TEND,QUART)
T     TMRMBRM1=0.0005/0.0121/0.0086/0.0191/0.0336/
X        0.0325/0.018/0.0239/0.03/0.0149/-0.0003/
X        0.0033/-0.0026/-0.0042/-0.015/-0.0091/0.0092

A     NMR.K=TABLE(TNMR,TIME,TSTR,TEND,QUART)
T      TNMR=0.15/0.1527/0.1782/0.213/0.188/
X         0.1874/0.1899/0.1888/0.1481/0.1282/0.1257/
X         0.1293/0.1222/0.118/0.1374/0.1439/0.1304

A     NMRM1.K=TABLE(TNMRM1,TIME,TSTR,TEND,QUART)
T      TNMRM1=0.1344/0.15/0.1527/0.1782/0.213/
X         0.188/0.1874/0.1899/0.1888/0.1481/0.1282/
X         0.1257/0.1293/0.1222/0.118/0.1374/0.1439

A     OHH.K=TABLE(TOHH,TIME,TSTR,TEND,ANNUAL)
T          TOHH=5084.327/5198.910/5311.882/5420.473/5525.655

A     RHH.K=TABLE(TRHH,TIME,TSTR,TEND,ANNUAL)
T          TRHH=3107.467/3171.688/3234.421/3292.948/3348.704
```

### 3.2 LAGS

There are two *DYNAMO* DELAYP functions used in the model: ownership and rental completions which are delayed functions of ownership and rental starts, respectively. The magnitude of the delays are determined by the exogenously defined constants OHSDEL and RHSDEL.

```
C       OHSDEL=Ø.25
C       RHSDEL=Ø.25
```

### 3.3 INITIAL CONDITIONS

The initial conditions (end of year 198Ø) were derived from the 1981 census. The census reported that in 1981 there were 5,141,94Ø occupied ownership units and 3,139,595 occupied rental units in Canada. Assuming that those figures reflect mid-year 1981 statistics, the estimated end of 198Ø numbers of ownership and rental households was determined by:

(1) subtracting half of the 1981 ownership starts (single-detached plus semi-detached) and rental starts (row plus apartment and other) from mid-year 1981 number of occupied ownership and rental units respectively, and

(2) adding half of the corresponding estimated 1981 demolitions.

The end of 198Ø number of ownership and rental units was then derived from the estimated number of occupied units by adding in a factor for vacancies. The rental vacancy factor was the October 198Ø average vacancy rate for all metropolitan centres (CMHC survey) of 2.2 per cent. Ownership vacancies were assumed to be slightly less and a 2.Ø per cent figure was assumed. The derivation is shown in the table below.

| | Census Occupied Units | Minus 1/2 of 1981 Starts | Plus 1/2 of 1981 Demolitions | Equals End 198Ø Households | Divide Vacancy Factor | Estimated Supply |
|---|---|---|---|---|---|---|
| **Owned** | 5,141,94Ø | - 38,567 | + 1Ø,ØØØ | = 5,113,373 | / Ø.98 | = 5,215,64Ø |
| **Rented** | 3,139,595 | - 5Ø,42Ø | + 6,ØØØ | = 3,Ø95,175 | / Ø.978 | = 3,164,8Ø1 |

The price indices were defined so that they equalled 1.Ø at the end of 198Ø.

```
N       TIME=1981

N       ON=5188.ØØ8
N       OH=5ØØ4.327
N       OP=1.Ø

N       RN=3177.367
N       RH=31Ø7.467
N       RP=1.Ø
```

### 3.4 DUMMY VARIABLES

A number of dummy variables are used in the model which, at any point in time take on a value of either "Ø" or "1". The values are set to the appropriate values using the *DYNAMO* STEP function. S1, S2, and S3 are seasonal dummies, and CHOSP is used to switch the CHOSP effects on for the four quarters 1982-III to 1983-II and off at other times.

```
A     S1.K=STEP(1,1981)-STEP(1,1981.25)+STEP(1,1982)-STEP(1,1982.25)
X        +STEP(1,1983)-STEP(1,1983.25)+STEP(1,1984)-STEP(1,1984.25)
A     S2.K=STEP(1,1981.25)-STEP(1,1981.5)+STEP(1,1982.25)-STEP(1,1982.5)
X        +STEP(1,1983.25)-STEP(1,1983.5)+STEP(1,1984.25)-STEP(1,1984.5)
A     S3.K=STEP(1,1981.5)-STEP(1,1981.75)+STEP(1,1982.5)-STEP(1,1982.75)
X        +STEP(1,1983.5)-STEP(1,1983.75)+STEP(1,1984.5)-STEP(1,1984.75)
A     CHOSP.K=STEP(1,1982.5)-STEP(1,1983.5)
```

### 3.5 PARAMETERS FOR TABLES

*DYNAMO* requires a number of constants to be set to facilitate the entry of exogenous data by means of TABLE functions. They are:

```
C     TSTR=1981
C     TEND=1985
C     ANNUAL=1.Ø
C     QUART=.25
```

### 3.6 POLICY VARIABLES

An equation is required to incorporate the effect of CHOSP on ownership price into the model. As discussed in section 3.2 (at p. 9) of the report, CHOSP is assumed to reduce the effective ownership price by 3 per cent of its end of 198Ø value. Hence, the adjusted ownership price (ADJOP) is calculated so that it equals OP when the CHOSP grants are not available and OP is reduced by 3 per cent when grants are available.

Three constants (SWTM, POLCHOSP, POLEQUIL) are also set in the policy section of the program which are used for switching the factors which differentiate the runs off and on. The changes made to produce the various runs are noted below.

```
A   ADJOP.K=OP.K-(SUBS*POLEQUIL*CHOSP.K)
C     SUBS=Ø.Ø3

C   SWTM=2ØØØ              Time interest rates are frozen
C   POLCHOSP=1             Speculative effect of CHOSP
C   POLEQUIL=1             Equilibrium effect of CHOSP
```

### 3.7 PRINT STATEMENTS

Several lines are included in the program to specify the outputs to be generated for the Base Case simulation run. They are:

```
PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
SAVE ON,OH,OHS,OP
SPEC DT=.Ø5/LENGTH=1985/PRTPER=.25/PLTPER=.25/SAVPER=.25
RUN BASIC - TOTAL CHOSP EFFECT & ACTUAL MORT. RATES
```

## 4. SPECIFICATION OF RERUNS

For each subsequent run, the variables that are changed must be shown and the desired output for the rerun specified.

### 4.1 SIMULATION WITHOUT SPECULATIVE EFFECT OF CHOSP (RUN #2)

Run #2 removes the speculative effect of CHOSP, while leaving the equilibrium effect in. The program written for the model is set up so that is accomplished by changing the value of the policy variable POLCHOSP from "1" to "Ø". The same output is specified as in the Base Case.

```
CP     POLCHOSP=Ø
PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUN POL2 - EQUILIBRIUM EFFECT OF CHOSP ONLY
```

### 4.2 SIMULATION WITHOUT EITHER CHOSP EFFECT (RUN #3)

Run #3 removes both the speculative and equilibrium effects of CHOSP. That is done by leaving POLCHOSP equal to "Ø" and also setting POLEQUIL equal to "Ø". The same output is specified as in the Base Case.

```
CP     POLEQUIL=Ø
PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUN POL3 - NO CHOSP
```

### 4.3 SIMULATION WITHOUT CHOSP WITH CONSTANT MORTGAGE RATES (RUN #4)

For Run #4, which assumes constant mortgage rates, the data for each of the exogenous variables which relates to the mortgage rate is redefined. In addition, the value of SWMT is changed to 1982.5, which has the effect of freezing the value of the real mortgage rate by changing the equation which calculates it. The values of the two CHOSP policy variables are left equal to "0"; hence, no CHOSP effect enters the simulation. Again, the same output is specified as was used for the Base Case.

```
TP    TMRMBR=0.0121/0.0086/0.0191/0.0336/0.0325/
X        0.018/0.0239/0.03/0.03/0.03/0.03/
X        0.03/0.03/0.03/0.03/0.03/0.03

TP    TMRMBRM1=0.0005/0.0121/0.0086/0.0191/0.0336/
X        0.0325/0.018/0.0139/0.03/0.03/0.03/
X        0.03/0.03/0.03/0.03/0.03/0.03

TP    TNMR=0.15/0.1527/0.1782/0.213/0.188/
X        0.1874/0.1899/0.1888/0.1888/0.1888/0.1888/
X        0.1888/0.1888/0.1888/0.1888/0.1888/0.1888

TP    TNMRM1=0.1344/0.15/0.1527/0.1782/0.213/
X        0.188/0.1874/0.1899/0.1888/0.1888/0.1888/
X        0.1888/0.1888/0.1888/0.1888/0.1888/0.1888

CP    SWTM=1982.5

PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUNNC POL4 - NO CHOSP & CONSTANT MORTGAGE RATES
```

### 4.4 SIMULATION WITH CHOSP AND CONSTANT MORTGAGE RATES (RUN #5)

Run #5, the final run, retains the constant mortgage rate data but reintroduces CHOSP into the model by resetting both POLCHOSP and POLEQUIL to "1". The output specification remains the same.

```
C     POLCHOSP=1
C     POLEQUIL=1
PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUNNC POL5 - CHOSP WITH CONSTANT MORTGAGE RATES
/*
//
```

# APPENDIX B

## LISTING OF THE DYNAMO PROGRAM AND

## DIAGRAMMATIC REPRESENTATION OF THE MODEL

**LISTING FOR THE SYSTEM DYNAMICS MODEL OF THE HOUSING MARKET**

```
//JDTJOB JOB (TY,9272,IKWK),'TODD'
/*JOBPARM L=10,NOLOG
/*ROUTE PRINT UTORONTO.JTODD
// EXEC DYNAMO,PARM='BATCH,PCL=12,PLW=65'
//BASIC DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL2 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL3 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL4 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//POL5 DD UNIT=SYSDA,SPACE=(TRK,(50,10))
//DYNA.SYSIN DD *

   ******
   ***  Supply - Ownership Sector  (thousands of units)
   ******

L    ON.K=ON.J+DT*(OHC.JK-OD.JK-OT.JK+RT.JK)
R    OHC.KL=DELAYP(OHS.K,OHSDEL,OHUC.K)
A    OHS.K=THTA0+THTA1*S1.K+THTA2*S2.K+THTA3*S3.K+
X        THTA4*(OP.K/CC.K)+THTA5*MRMBRM1.K+THTA6*RMRM1.K+
X        POLCHOSP*SPECDEM*CHOSP.K
C           THTA0=6.33
C           THTA1=-41.5
C           THTA2=19.84
C           THTA3=10.63
C           THTA4=115.04
C           THTA5=-1478.5
C           THTA6=-326.5
C           SPECDEM=32.42

R    OD.KL=MAX(ODF.K*ON.K,0)
A    ODF.K=ODFC*(2-(OP.K/GNED.K))
C           ODFC=0.004

R    OT.KL=MAX(OTF.K*ON.K,0)
A    OTF.K=OTFC*(1+(RP.K/OP.K))
C           OTFC=0.01

L    OHSACC.K=OHSACC.J+DT*OHS.J
N    OHSACC=0.0

   ******
   ***  Quality of New Ownership Housing  (Index = 1.00 at end 4Q 1980)
   ******

A    OQ.K=(PI0+PI1*(OP.K/GNED.K)+PI2*RY.K)/OQSF
C           PI0=33.411
C           PI1=-28.38
C           PI2=15.727
C           OQSF=101.48
```

```
   ******
   ***  Demand - Ownership Sector  (thousands of households)
   ******

A    OH.K=(OHH.K*OSF*(AØ+A1*RY.K+A2*(ADJOP.K/RP.K)+
X      A3*INFLR.K+A4*MRMBR.K+A5*RMR.K))+POLCHOSP*SPECDEM*CHOSP.K
C           AØ=Ø.9310
C           A1=Ø.ØØ63185
C           A2=-Ø.Ø7134
C           A3=Ø.7318
C           A4=-Ø.8255
C           A5=Ø.5542
C           OSF=1.Ø1192

   ******
   ***  Price - Ownership Sector  (Index = 1ØØ at end 4Q 198Ø)
   ******

L    OP.K=OP.J+DT*OPR.JK
R    OPR.KL=OP.K*(BETAØ+BETA1*MIN(5,((NOVR-OVR.K)/
X         FIFGE(OVR.K,-OVR.K,OVR.K,Ø)))+
X         BETA2*INFLR.K+BETA3*RMRCH.K+BETA4*POLCHOSP*CHOSP.K)
C           BETAØ=-Ø.Ø16Ø56
C           BETA1=Ø.ØØ4126
C           BETA2=Ø.636435
C           BETA3=Ø.Ø56428
C           BETA4=-Ø.Ø7644

A    OVR.K=((ON.K-OH.K)/ON.K)*1ØØ
C           NOVR=3.Ø

   ******
   ***  Supply - Market Rental Sector  (thousands of units)
   ******

L    RN.K=RN.J+DT*(RHC.JK-RD.JK+OT.JK-RT.JK)
R      RHC.KL=DELAYP(RHS.JK,RHSDEL,RHUC.K)

A    RHS.K=TAUØ+TAU1*S1.K+TAU2*S2.K+TAU3*S3.K+
X        TAU4*(RP.K/GNED.K)+TAU5*(CC.K/GNED.K)+
X        TAU6*MRMBRM1.K+TAU7*RMRM1.K
C           TAUØ=-258.76
C           TAU1=-29.7
C           TAU2=-7.94
C           TAU3=-4.81
C           TAU4=73.88
C           TAU5=241.5
C           TAU6=778.26
C           TAU7=41.484

R    RD.KL=MAX(RDF.K*RN.K,Ø)
A    RDF.K=RDFC*(2-(RP.K/GNED.K))
C           RDFC=Ø.ØØ4
```

```
R   RT.KL=MAX(RTF.K*RN.K,Ø)
A   RTF.K=RTFC*(1+(OP.K/RP.K))
C           RTFC=Ø.Ø15

L   RHSACC.K=RHSACC.J+DT*RHS.J
N   RHSACC=Ø.Ø

    ******
    ***  Demand - Market Rental Sector  (thousands of households)
    ******

A   RH.K=RHH.K*RSF*(BØ+B1*RY.K+B2*(OP.K/RP.K)+B3*INFLR.K+
X     B4*MRMBR.K+B5*RMR.K)
C           BØ=1.ØØ7596
C           B1=Ø.ØØ1625
C           B2=Ø.11345
C           B3=-Ø.91645
C           B4=Ø.9849
C           B5=-Ø.92289
C           RSF=Ø.99107

    ******
    ***  Price - Market Rental Sector  (Index = 1.ØØ at end 4Q 198Ø)
    ******

L   RP.K=RP.J+DT*RR.JK
R   RR.KL=RP.K*(ALPHAØ+ALPHA1*INFLR.K+ALPHA2*(NVR-VR.K)+
X     ALPHA3*RMR4Q.K)
C           ALPHAØ=-Ø.Ø1588
C           ALPHA1=Ø.36726
C           ALPHA2=Ø.Ø1287
C           ALPHA3=Ø.45882

A   VR.K=((RN.K-RH.K)/(RN.K))*1ØØ
C           NVR=4.Ø

    ******
    ***  Exogenous Variables
    ******

A     RY.K=TABLE(TRY,TIME,TSTR,TEND,QUART)
T      TRY=6.132829/5.996729/6.526216/7.ØØ7641/6.311Ø76/
X       5.974495/6.469802/6.878981/6.ØØ4359/5.687665/6.193829/
X       6.882674/6.138344/5.751281/6.45Ø998/6.853831/6.298364

A     CC.K=TABLE(TCC,TIME,TSTR,TEND,QUART)
T      TCC=1.ØØØØ/1.Ø279/1.Ø885/1.Ø776/1.Ø828/
X       1.Ø894/1.1282/1.1425/1.1722/1.2Ø14/1.282Ø/
X       1.25Ø2/1.2554/1.282Ø/1.272Ø/1.2738/1.2921

A     INFLR.K=TABLE(TINFLR,TIME,TSTR,TEND,QUART)
T     TINFLR=Ø.1Ø68/Ø.1Ø98/Ø.ØØ97/Ø.1123/Ø.1Ø93/
X        Ø.1133/Ø.1Ø92/Ø.Ø922/Ø.1Ø25/Ø.Ø782/Ø.Ø644/
X        Ø.Ø495/Ø.Ø283/Ø.Ø349/Ø.Ø352/Ø.Ø228/Ø.Ø29Ø
```

```
A      INFLRM1.K=TABLE(TINFLRM1,TIME,TSTR,TEND,QUART)
T      TINFLRM1=Ø.1107/Ø.1068/Ø.1098/Ø.Ø897/Ø.1123/
X         Ø.1093/Ø.1133/Ø.1092/Ø.Ø922/Ø.1025/Ø.Ø782/
X         Ø.Ø644/Ø.Ø495/Ø.Ø283/Ø.Ø349/Ø.Ø352/Ø.Ø228

A      GNED.K=TABLE(TGNED,TIME,TSTR,TEND,QUART)
T       TGNED=1.ØØØØ/1.Ø348/1.Ø564/1.1183/1.1Ø93/
X         1.152Ø/1.1718/1.2214/1.223Ø/1.2421/1.2473/
X         1.2818/1.2576/1.2854/1.2912/1.311Ø/1.2941

A      RMR4Q.K=TABLE(TRMR4Q,TIME,TSTR,TEND,QUART)
T      TRMR4Q=Ø.ØØ2861/Ø.Ø27Ø3/Ø.Ø5ØØ2/Ø.Ø3734/Ø.Ø5785/
X         Ø.Ø6262/Ø.Ø743Ø/Ø.ØØ374/Ø.Ø78Ø3/Ø.ØØ3Ø6/Ø.ØØ331/
X         Ø.ØØ362/Ø.1Ø166/Ø.ØØ841/Ø.ØØ559/Ø.1Ø163/Ø.ØØ849

A      RMRCH.K=(RMR.K-RMRM1.K)/RMRM1.K
A      RMR.K=FIFGE(.ØØ844,((1+NMR.K)/(1+INFLR.K))-1,TIME.K,SWTM)
A      RMRM1.K=FIFGE(.ØØ844,((1+NMRM1.K)/(1+INFLRM1.K))-1,
X         TIME.K,SWTM+Ø.25)

A      MRMBR.K=TABLE(TMRMBR,TIME,TSTR,TEND,QUART)
T      TMRMBR=Ø.Ø121/Ø.ØØ86/Ø.Ø191/Ø.Ø336/Ø.Ø325/
X         Ø.Ø18/Ø.Ø239/Ø.Ø3/Ø.Ø149/-Ø.ØØØ3/Ø.ØØ33/
X         -Ø.ØØ26/-Ø.ØØ42/-Ø.Ø15/-Ø.ØØ91/Ø.ØØ92/Ø.ØØ5

A      MRMBRM1.K=TABLE(TMRMBRM1,TIME,TSTR,TEND,QUART)
T      TMRMBRM1=Ø.ØØØ5/Ø.Ø121/Ø.ØØ86/Ø.Ø191/Ø.Ø336/
X         Ø.Ø325/Ø.Ø18/Ø.Ø239/Ø.Ø3/Ø.Ø149/-Ø.ØØØ3/
X         Ø.ØØ33/-Ø.ØØ26/-Ø.ØØ42/-Ø.Ø15/-Ø.ØØ91/Ø.ØØ92

A      NMR.K=TABLE(TNMR,TIME,TSTR,TEND,QUART)
T       TNMR=Ø.15/Ø.1527/Ø.1782/Ø.213/Ø.188/
X          Ø.1874/Ø.1899/Ø.1888/Ø.1481/Ø.1282/Ø.1257/
X          Ø.1293/Ø.1222/Ø.118/Ø.1374/Ø.1439/Ø.13Ø4

A      NMRM1.K=TABLE(TNMRM1,TIME,TSTR,TEND,QUART)
T       TNMRM1=Ø.1344/Ø.15/Ø.1527/Ø.1782/Ø.213/
X          Ø.188/Ø.1874/Ø.1899/Ø.1888/Ø.1481/Ø.1282/
X          Ø.1257/Ø.1293/Ø.1222/Ø.118/Ø.1374/Ø.1439

A      OHH.K=TABLE(TOHH,TIME,TSTR,TEND,ANNUAL)
T          TOHH=5Ø84.327/5198.91Ø/5311.882/542Ø.473/5525.655

A      RHH.K=TABLE(TRHH,TIME,TSTR,TEND,ANNUAL)
T          TRHH=31Ø7.467/3171.688/3234.421/3292.948/3348.7Ø4

   ******
   ***  Lags
   ******

C      OHSDEL=Ø.25
C      RHSDEL=Ø.25
```

```
   ******
   ***  Initial Conditions
   ******

N     TIME=1981

N     ON=5188.088
N     OH=5084.327
N     OP=1.0
N     RN=3177.367
N     RH=3107.467
N     RP=1.0

   ******
   ***  Dummy Variables
   ******

A     S1.K=STEP(1,1981)-STEP(1,1981.25)+STEP(1,1982)-STEP(1,1982.25)
X        +STEP(1,1983)-STEP(1,1983.25)+STEP(1,1984)-STEP(1,1984.25)
A     S2.K=STEP(1,1981.25)-STEP(1,1981.5)+STEP(1,1982.25)-STEP(1,1982.5)
X        +STEP(1,1983.25)-STEP(1,1983.5)+STEP(1,1984.25)-STEP(1,1984.5)
A     S3.K=STEP(1,1981.5)-STEP(1,1981.75)+STEP(1,1982.5)-STEP(1,1982.75)
X        +STEP(1,1983.5)-STEP(1,1983.75)+STEP(1,1984.5)-STEP(1,1984.75)
A     CHOSP.K=STEP(1,1982.5)-STEP(1,1983.5)

   ******
   ***  Parameters for Tables
   ******


C     TSTR=1981
C     TEND=1985
C     ANNUAL=1.0
C     QUART=.25

   ******
   ***  Policy Variables
   ******

A    ADJOP.K=OP.K-(SUBS*POLEQUIL*CHOSP.K)
C       SUBS=0.03
C    SWTM=2000              TIME INTEREST RATES ARE FROZEN
C    POLCHOSP=1             SPECULATIVE EFFECT OF CHOSP
C    POLEQUIL=1             EQUILIBRIUM EFFECT OF CHOSP

   ******
   ***  Print Statements
   ******

PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
SAVE ON,OH,OHS,OP
SPEC DT=.05/LENGTH=1985/PRTPER=.25/PLTPER=.25/SAVPER=.25
RUN BASIC - TOTAL CHOSP EFFECT & ACTUAL MORT. RATES
```

```
CP      POLCHOSP=Ø
PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUN POL2 - EQUILIBRIUM EFFECT OF CHOSP ONLY

CP      POLEQUIL=Ø
PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUN POL3 - NO CHOSP

TP      TMRMBR=Ø.Ø121/Ø.ØØ86/Ø.Ø191/Ø.Ø336/Ø.Ø325/
X         Ø.Ø18/Ø.Ø239/Ø.Ø3/Ø.Ø3/Ø.Ø3/Ø.Ø3/
X         Ø.Ø3/Ø.Ø3/Ø.Ø3/Ø.Ø3/Ø.Ø3/Ø.Ø3

TP      TMRMBRM1=Ø.ØØØ5/Ø.Ø121/Ø.ØØ86/Ø.Ø191/Ø.Ø336/
X         Ø.Ø325/Ø.Ø18/Ø.Ø139/Ø.Ø3/Ø.Ø3/Ø.Ø3/
X         Ø.Ø3/Ø.Ø3/Ø.Ø3/Ø.Ø3/Ø.Ø3/Ø.Ø3

TP      TNMR=Ø.15/Ø.1527/Ø.1782/Ø.213/Ø.188/
X         Ø.1874/Ø.1899/Ø.1888/Ø.1888/Ø.1888/Ø.1888/
X         Ø.1888/Ø.1888/Ø.1888/Ø.1888/Ø.1888/Ø.1888

TP      TNMRM1=Ø.1344/Ø.15/Ø.1527/Ø.1782/Ø.213/
X         Ø.188/Ø.1874/Ø.1899/Ø.1888/Ø.1888/Ø.1888/
X         Ø.1888/Ø.1888/Ø.1888/Ø.1888/Ø.1888/Ø.1888

CP      SWTM=1982.5

PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUNNC POL4 - NO CHOSP & CONSTANT MORTGAGE RATES

C       POLCHOSP=1
C       POLEQUIL=1
PRINT ON,RN,OH,RH,VR
PRINT OHS,RHS,OP,RP,OVR
PRINT OHUC,RHUC,OQ,RHSACC,OHSACC
CPLOT OHS.BASIC=S,OHS=T/ON.BASIC=N,ON=M,OH.BASIC=D,OH=E/OP.BASIC=P,OP=Q
RUNNC POL5 - CHOSP WITH CONSTANT MORTGAGE RATES
/*
//
```

## DEFINITIONS FOR THE SYSTEM DYNAMICS DIAGRAM OF THE MODEL

The diagram on the following page presents the structure of the model using standard system dynamics symbols[1] except as noted. The diagram shows the simplest housing market, without separate controlled and market rental sectors. For the sake of simplicity, disaggregation of owned housing demand into demand for new and existing units is not shown. All relationships not shown follow the pattern of the ownership and rental variables represented in the diagram.

The ownership and rental sectors are schematically identical, except for the CHOSP variable. The definitions of the variables are given below, with the corresponding ownership and rental variables starting with "O" and "R", respectively, defined together.

ON, RN - number of housing units

OD, RD - demolitions

ODF, RDF - demolition factor

OT, RT - conversion (transfers ownership to rental, and reverse)

OTF, RTF - conversion factor

OC, RC - completions

OS, RS - starts

OP, RP - price

OR, RR - rate of change in the price

OH, RH - effective demand

OVR, RVR - vacancy rate

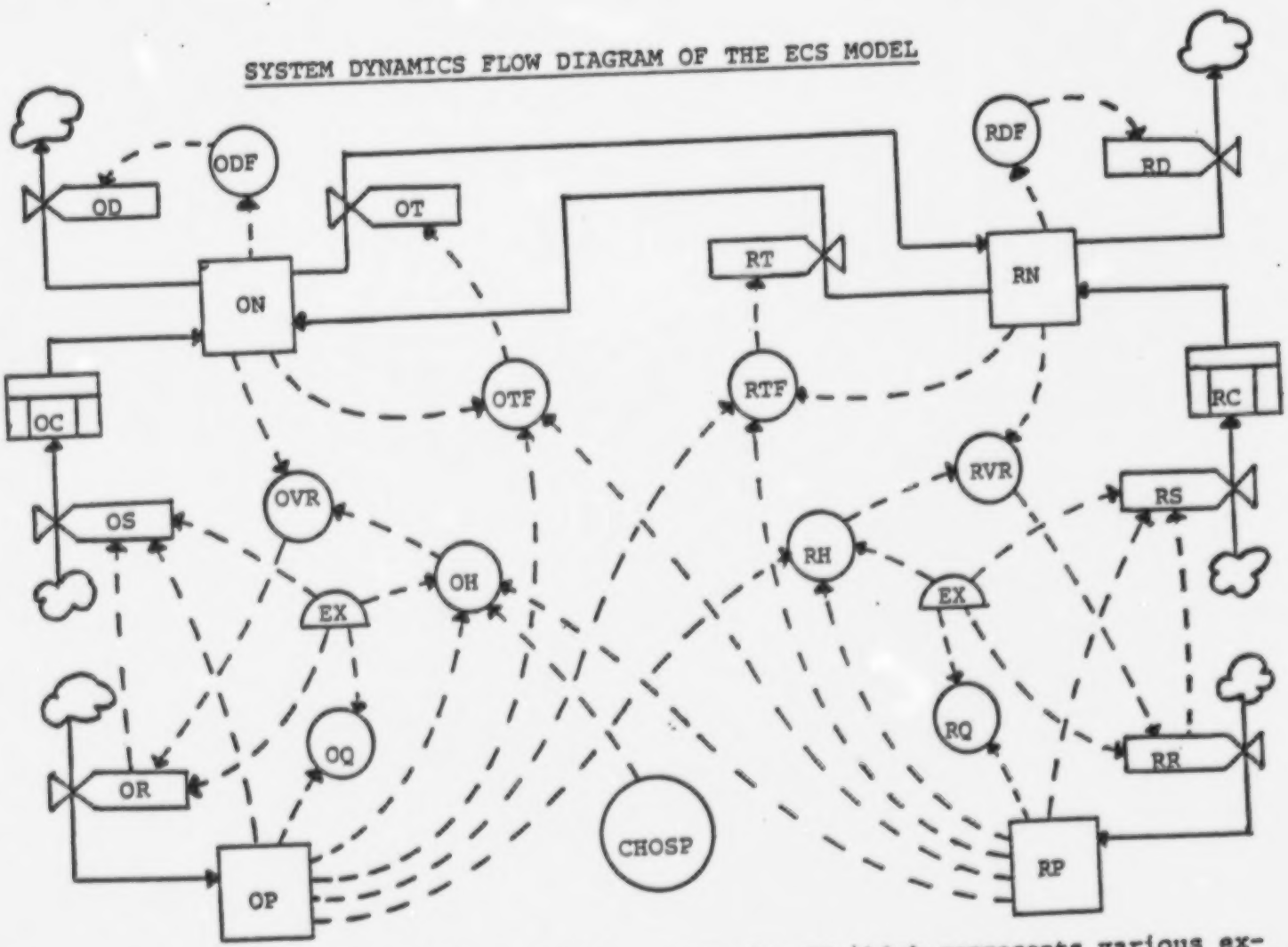
OQ, RQ - quality of new housing

EX - various exogenous factors

CHOSP

[1] See for example, Alexander L. Pugh III (1976) Dynamo User's Manual, Fifth Edition, Cambridge: MIT Press.

SYSTEM DYNAMICS FLOW DIAGRAM OF THE ECS MODEL




Symbols are standard system dynamics notation except for EX which represents various exogenously determined variables including population, inflation, income, mortgage, rates etc.

The diagram has been simplified by (i) not showing disaggregation of the rental sector into the rent controlled and market segments, (ii) not separating ownership demand for CHOSP qualifications, and (iii) collapsing some sequences of equations into a single symbol.

# APPENDIX C

# DATA SOURCES AND ECONOMETRIC RESULTS

## APPENDIX C - DATA SOURCES AND ECONOMETRIC RESULTS

### 1. ECONOMETRIC ESTIMATIONS

Eight key relationships in the model were estimated econometrically; four in the ownership sector, and four in the rental sector. For each sector, they are:

- starts,
- price adjustment,
- demand, and
- quality.

This appendix presents the basis for the specifications of each estimated equation, the data sources used and the econometric results.

#### Ownership Starts

The estimation of the ownership starts equation serves two important functions in the project. First, it provides an econometric estimate of the total impact of CHOSP on starts. Second, it serves as the basis for the starts equation in the system dynamics model.

Smith (1969a, 1969b and 1974a) provides an excellent starting point for determining the specification for the starts equation to be estimated. He integrates models of the housing and mortgage markets.[1] In which,

> The volume of new housing construction actually undertaken depends on this [residential construction] profitability and the availability of mortgage credit. The financial variables entering this process are linked to the housing sector via the mortgage market, where the cost and availability of mortgage credit are determined. The availability of mortgage credit depends upon financial institution willingness to make mortgage loans and upon the size of their investment portfolios, while the cost is determined by the interaction of the demand and supply of this credit. (Smith 1969, p. 796)

Housing starts are then treated as a function of (1) the price of housing, (2) the vacancy rate, (3) construction and land costs, and (4) the cost and availability of private and public mortgage credit. Hence, Smith (1969a, 1969b, 1974a) used starts equations of the form[2]:

$$HS_t = a_0 - a_1S_1 + a_2S_2 + a_3S_3 + a_4WW + a_5(Ph/CC)_t - a_6rm_{t-1} + a_7(rm - rb)_{t-1} + a_8CMHC_t + a_9CMHC_{t-1} \qquad (1)$$

1. See also Sparks (1967).
2. In Smith (1969b), equations similar to (1) are estimated separately for single-family and multiple housing starts.

where

HS is quarterly housing starts (thousands)
Ph is price of dwelling units
CC is construction and land costs
rm is the mortgage rate
rb is the yield on long term bonds
$S_1$, $S_2$, $S_3$ are seasonal dummy variables
WW is a dummy for winter works (relevant for 1963-65 only)
CMHC is mortgage lending by CMHC

Construction costs, in turn, are assumed by Smith (1969a) to depend on (1) the average hourly earnings in construction, (2) temporary or bridge financing costs, (3) land costs, (4) the cost of building materials (sales tax included), and (5) "delays and bottlenecks that arise as current residential and non-residential construction activities press against their respective industrial capacities." Land costs are assumed to be a function of population, permanent real disposable income and expectations as to future land prices.

Two equations similar to Smith's were estimated using quarterly data for the period 1976 to 1984. The dummy for winter works used by Smith was dropped since the relevant years were 1963 to 1965. The CMHC variables were also eliminated since CMHC has not been an important source of mortgage funds since 1975[3].

Two dummy variables related to CHOSP were added to the specification. The first represents the impact of the CHOSP program during the last two quarters of 1982 and the first two quarters of 1983. The second, PSTCHOSP, appears only in the first of the two estimations. It represents the rebound effect of CHOSP in the four quarters after the CHOSP program was terminated. Hence, the first relationship estimated was:

$$OHS = h(Ph/CC, rm, rm-rb, CHOSP, PSTCHOSP, S1, S2, S3) \qquad (2)$$

The estimated ownership housing starts results are (t-statistics appear in brackets)[4]:

$$\underset{}{OHS_t} = \underset{(\emptyset.36)}{5.42} - \underset{(-4.47)}{11.14S_1} + \underset{(1.51)}{3.92S_2} + \underset{(1.69)}{4.14S_3} + \underset{(1.94)}{27.58(Ph/CC)_t} - \underset{(-1.85)}{79.55rm_t}$$

$$- \underset{(-3.51)}{379.59(rm - rb)_{t-1}} + \underset{(2.27)}{7.83CHOSP_t} - \underset{(-\emptyset.27)}{1.\emptyset3PSTCHOSP_t} \qquad (2a)$$

1Q 76 - 4Q 84, $\bar{R}^2$ = .72, RMSE = 5.17

The coefficients in equation (2a) are used to estimate the total impact of CHOSP including its rebound effect. A second equation was

3. See Table 34 in CMHC, Canadian Housing Statistics (1984) or other recent issues. From 1954 to 1967, CMHC financed an average of almost 20,000 units annually. From 1968 to 1975, the level of activity declined, but there was still an average of almost 15,000 units financed by CMHC in that period. Since then, the number of CMHC mortgages have averaged less than 500 annually.
4. The estimation period, adjusted $R^2$, and root mean square error of the estimate are reported below each regression. Data sources are listed in the table at the end of Appendix C.

estimated in which the PSTCHOSP term was deleted since that term is not significant. The results of that estimation are:

$$OHS_t = \underset{(\emptyset.29)}{4.13} - \underset{(-4.61)}{11.23}S_1 + \underset{(1.55)}{3.95}S_2 + \underset{(1.73)}{4.15}S_3 + \underset{(2.17)}{28.76}(Ph/CC)_t - \underset{(-1.96)}{81.62}rm_t$$
$$- \underset{(-3.7\emptyset)}{369.6}(rm - rb)_{t-1} + \underset{(2.5\emptyset)}{8.11}CHOSP_t \qquad (2b)$$

1Q 76 - 4Q 84, $\bar{R}^2$ = .73, RMSE = 5.Ø9

All coefficients except the intercept, $S_2$ and $S_3$ are significant at the .Ø5 level.

The ownership starts equation in the system dynamics model of the housing market is based on equation (2b). All coefficients are multiplied by four to convert the equation to equivalent annual rates.

A third specification, with the CHOSP variable lagged one quarter, was estimated for the static analysis. The results are:

$$OHS_t = \underset{(-\emptyset.17)}{-2.48} - \underset{(-4.79)}{11.23}S_1 + \underset{(1.79)}{4.36}S_2 + \underset{(1.83)}{4.23}S_3 + \underset{(2.57)}{34.31}(Ph/CC)_t - \underset{(-1.61)}{65.56}rm_t$$
$$- \underset{(-3.76)}{342.1}(rm - rb)_{t-1} + \underset{(2.98)}{9.19}CHOSPLAG_t \qquad (2c)$$

1Q 76 - 4Q 84, $\bar{R}^2$ = .75, RMSE = 4.9Ø

The intercept, $S_2$, $S_3$ and $rm_t$ are the only coefficients that are not significant[5].

## 1.2 RENTAL STARTS

The equation estimated for rental housing starts is similar to that used for ownership starts[6], except that the CHOSP terms are left out since that program was directed primarily at the ownership market. In addition, the price variable was split into two separate variables: the real rental price (Rh), and real construction costs (RCC). The estimated rental housing starts results are:

$$RHS_t = \underset{(-4.59)}{-64.75} - \underset{(-4.51)}{7.84}S_1 - \underset{(-\emptyset.66)}{1.14}S_2 + \underset{(\emptyset.12)}{\emptyset.21}S_3 + \underset{(7.3\emptyset)}{18.47}Rh_t$$
$$+ \underset{(4.91)}{6\emptyset.37}RCC_t - \underset{(-\emptyset.56)}{1\emptyset.37}rm_t + \underset{(2.31)}{194.6}(rm - rb)_{t-1} \qquad (3)$$

1Q 76 - 4Q 84, $\bar{R}^2$ = .52, RMSE = 5.26

All coefficients are significant except $rm_t$, $S_2$, and $S_3$.

5. The standard errors (SE) for the CHOSP terms in the three equations are: in (2a), for CHOSP SE= 3.446 and for PSTCHOSP SE= 3.833; for (2b), in CHOSP SE= 3.241; in (2c), for CHOSPLAG SE= 3.Ø89.
6. Smith (1969b) also uses similar equations for estimating both single-family and multiple housing starts.

The rental starts equation in the system dynamics model of the housing market is based on equation (3). All coefficients are multiplied by four to convert the equation to equivalent annual rates.

### 1.3 OWNERSHIP DEMAND

Follis (1985, pp. 27-34) notes that if housing is viewed as a standard commodity, then per household demand for housing services is a function of three economic variables: the price of housing services, the price of other goods, and household income. Additional variables have often been included by other researchers. For example, Smith et al (1984) consider headship rates (per capita demand) to be a function of price, income, availability of public housing, and "socio-economic variables embodying such influences as the divorce rate and the female participation rate."

The equation estimated for the ownership demand sector of the dynamic model treats per normalized household demand as a function of (1) household income, (2) the ratio of the ownership and rental price indices, (3) the inflation rate (gross national expenditure deflator), (4) the difference between the mortgage and bond rates, and (5) the real mortgage rate[7]. The resulting specification is:

$$OD_t = b_0 + b_1 Y_t + b_2(P_t/R_t) + b_3 G_t + b_4 rm_t + b_5(rm - rb)_{t-1} \qquad (4)$$

where

P is the real price of ownership housing
R is the real price of rental housing
Y is real income
G is the gross national expenditure deflator

The estimated ownership demand per household is:

$$OD_t = \underset{(15.27)}{0.931} + \underset{(0.92)}{0.00632 Y_t} - \underset{(-1.53)}{0.0713(P_t/R_t)} + \underset{(4.72)}{0.732 G_t}$$

$$+ \underset{(4.38)}{0.554 rm_t} - \underset{(-2.27)}{0.825(rm - rb)_{t-1}} \qquad (4a)$$

1Q 76 - 4Q 84, $\bar{R}^2 = .54$, RMSE = 0.129

Income and the price ratio are not significant.

Equation (4a) is multiplied by the normalized number of ownership households, as discussed in Appendix A, to determine ownership demand in the model.

7. An exogenous variable in the model is the normalized number of households, which equals the number of households there would have been in each quarter assuming headship rates by age and sex were constant at their 1981 rates. That represents the demand if all economic and demographic factors except population growth and changes in the age and sex distribution of the population were constant. Demand per normalized household is the ratio of the actual number of households to the normalized number of households. Appendix A contains a more complete discussion of normalized demand per household.

## 1.4 RENTAL DEMAND

The equation estimated for rental demand per normalized household parallels the ownership demand equation. The same specification, equation (4), is used. It may be noted that several of the independent variables affect both total housing demand and the tenure split. When the signs in the corresponding coefficients in the two equations are opposite, it indicates that the tenure choice effect dominates the total housing demand effect. The estimated ownership demand per household is:

$$RD_t = \underset{(25.64)}{1.000} + \underset{(0.37)}{0.00163Y_t} + \underset{(3.77)}{0.113(P_t/R_t)} - \underset{(-9.17)}{0.916G_t}$$

$$- \underset{(-11.33)}{0.923rm_t} + \underset{(4.21)}{0.985(rm - rb)_{t-1}} \qquad (4a)$$

1Q 76 - 4Q 84, $\bar{R}^2$ = .88, RMSE = 0.00828

The estimate of per household ownership demand is multiplied by the normalized number of ownership households, as discussed in Appendix A, to determine ownership demand in the model.

## 1.5 RENTAL PRICE CHANGE

A useful approach for modeling the price-adjustment mechanism for rental housing has been developed and applied empirically through a series of articles by Blank and Winnick (1953), Smith (1974b), Eubank and Sirmans (1979), Rosen and Smith (1983), and Fallis and Smith (1984). The basic model, as set out in Rosen and Smith (1983, pp. 780-1), takes the form:

$$\dot{R} = r(\dot{E}, V^n - V) \qquad (5)$$

where

$\dot{R}$ is the rate of change of nominal rents,

$\dot{E}$ is the rate of change of total operating expenditures,
$V^n$ is the natural vacancy rate, and
$V$ is the actual vacancy rate.

This basic model was used to specify an equation for the rate of change in the price of rental housing. Given the important role of changing interest rates throught the CHOSP period, one additonal variable was added to the specification - the real mortgage rate. Landlords' costs are determined not only by their total operating expenditures but also by their financing costs. Market rents, therefore, should depend on interest rates as well as operating costs. Hence, the equation estimated for the change in rental price is:

$$\dot{R} = r(\dot{E}, rm, V^n - V) \qquad (6)$$

where

$\dot{E}$ is the rate of change in operating costs (approximated by the change in the gross national expenditure deflator), and
rm is the real mortgage rate (annual average rate).

The results of the estimation are:

$$\dot{R}_t = \underset{(-2.07)}{-\ 0.0159} + \underset{(4.73)}{0.367\dot{E}_t} + \underset{(8.36)}{0.459rm_t} + \underset{(7.06)}{0.0129(V^n - V_t)} \qquad (6a)$$

1Q 76 - 4Q 84, $\bar{R}^2$ = .90, RMSE = 0.00740

All coefficients are significant.

The rental price sector in the model uses equation (4). The equation was run for annualized price changes; hence, the coefficients were not seasonally adjusted for use in the model.

## 1.6 OWNERSHIP PRICE CHANGE

The estimated equation for the ownership price sector of the model is similar to equation (6), except a dummy variable was added for CHOSP. The results of the estimation are:

$$\dot{P}_t = \underset{(-0.63)}{-\ 0.0161} + \underset{(2.06)}{0.636\dot{E}_t} + \underset{(2.09)}{0.0564\dot{rm}_t} + \underset{(1.53)}{0.00413(OV^n - OV_t)}$$

$$\underset{(-3.07)}{-\ 0.0764CHOSP} \qquad (6b)$$

1Q 76 - 4Q 84, $\bar{R}^2$ = .65, RMSE = 0.0394

The intercept and vacancy rate coefficients are not significant.

The rental price sector in the model uses equation (6b). The equation was run for annualized price changes; hence, the coefficients were not seasonally adjusted for use in the model.

## 1.7 QUALITY OF NEW OWNERSHIP HOUSING

The housing literature offers little assistance in determining housing quality. For purposes of the model, quality is measured as the average liveable floor area for new single detached dwellings financed under the NHA. Utilizing a conventional demand for quality specification, the econometric estimation treats household income and the ratio of the ownership price index to the GNE deflator (that ratio is an index of real ownership price) determine housing quality. Hence, the equation estimated for the quality of new ownership housing is:

$$Q = q(Y, P/G) \qquad (7)$$

The results of the estimation are:

$$Q_t = 33.411 + 15.727Y_t - 28.380(P_t/G_t) \qquad (7a)$$
$$\qquad (0.47) \quad (1.48) \quad (-2.63)$$

1Q 76 - 4Q 84, $\bar{R}^2 = .58$, RMSE = 3.977

The intercept and household income coefficients are not significant.

The ownership housing quality sector in the model uses equation (7a).

## 2. RELATIONSHIPS NOT ECONOMETRICALLY ESTIMATED

The demolition and conversion rates had to derived without the benefit of formal econometric analysis. The derivation of each is described below.

### 2.1 DEMOLITION RATE

Very little empirical information exists on demolition rates. An estimate was derived by de Leeuw (1972; pp. 46-59) based on a paper by Fukushima (1972) on new housing construction which used U. S. data from the 1950's and 60's. In the process of deriving the rate of deterioration of housing stock, de Leeuw finds an estimated "normal removal rate" of between 0.4 and 0.8 per cent per annum. In an earlier paper, Donnison (1967) notes that the rate of replacement of the European housing stock is generally recognized to be less than 0.5 per cent per annum.

Vischer Skaburskis (1979; Table 1, p.9) for CMHC estimated the much lower demolition rate of 0.17 per cent per annum for Canada using data from the early 1970's. That figure implies that if the number of new units built were fairly stable through the decades, the life expectancy of the average building would be almost 600 years. It seems reasonable to assume that this finding may reflect the economic conditions during the years studied and the age distribution of the stock at the time, rather than long term trends. The model assumes a normal demolition rate of 0.4 per cent per annum, which is more consistent with international, long-term experience. That figure also appears more consistent with the engineering view of the expected lifetime of post-war construction, given the age distribution of the stock at the present time.

F.W. Smith (1966, pp. 38-50) notes that "housing units are demolished for a variety of reasons unrelated to age and might almost be said to have no necessary economic mortality." The demolition decision is primarily a question of comparing the present value of the land occupied by the present physical structure to its present value in an alternate use. That conclusion implies that demolitions should be determined as a function of the relative profitability of land in alternate uses. Most important, high vacancy rates and low income levels in its present use will indicate an increased demolition rate, ceteris paribus.

In the model, the normal demolition rates of the ownership and rental stocks are assumed to be the same; however, an economic factor is included which adjusts the demolition rates, creating differences in the effective demolition rates when the opportunity costs of not demolishing buildings differ.

## 2.2 CONVERSION RATES

Rothenberg (1973) developed a model which considers the convertibility (as well as durability and heterogeneity) of housing stock. In his model, conversion is dealt with in its most generalized sense. Conversion is any change in the flow of housing services available from a dwelling unit. That would include not only conversion from a single-family dwelling to a multiple-family dwelling, but also renovation to a higher quality housing unit or the gradual reduction of quality through undermaintenance. Using that definition, all conversions do not involve a change of tenure.

In the model, two types of conversion are important:

- changes in tenure, which may not involve a change in the housing services available (eg. an owner-occupied house or condominium may be rented without any physical conversion), and

- changes in the number of units (eg. a building with 20 small apartments may undergo a luxury renovation, converting it to abuilding with ten larger units).

Both types of conversion may occur simultaneously. For example, an owner-occupied single family detached unit may be converted to a multiple family rental dwelling with a couple of apartment units or several bachelorettes.

Although Rothenberg defines conversions in a different manner than is used in this paper, his conceptual model for determining net conversions and new construction is generalisable. Rothenberg (1973, p. 32) notes that

> the size of the net conversion additions to any [quality] $Q_i$ depends on:
>
> a) the number of units at relevantly higher levels than $Q_i$;
> b) the number of units at $Q_i$;
> c) the average threshold immobilities at these different levels;
> d) the relative rise of prices at the different quality levels both above and below $Q_i$. Large rises at lower levels increases the incentive to convert downward and increases the size of the desirable conversion.
>
> The size of the additions to $Q_i$ from new construction depend on:
>
> a) the absolute size of price rise at $Q_i$;
> b) the size of price rises at all other Q levels.
>
> What is important here is the absolute size of the returns relative to the cost of capital, and the relative attraction of $Q_i$ in comparison with other quality levels.

One implication of Rothenberg's paper is that conversion and new construction are substitutes. The relative cost of supplying units in these two ways will differ with the level of quality and with the balance between supply and demand at each quality level. However, those conversions refinements cannot be modeled without the market being disggregation on the

basis of quality. Since that is not done in the dynamic model for this project, the treatment of conversions in the model is quite simple. Given the difficulty of measuring housing quality in a meaningful way (quality is a multi-dimensional variable, which cannot be meaningfully collapsed into a scalar since the substitutability of different dimensions of quality is limited), it will be extremely difficult to develop an economic model of the conversion process with good predictive powers.

Rothenberg's work, while assisting with the conceptual framework for handling conversions, is of little assistance in determining appropriate conversion rates. No other substantive evidence was available at the time of developing the model. Conversion rates were deduced from the Census statistics for the number of ownership and rental units from 1971 to 1981 and the demolition rates in the model. The rate of conversion from ownership to rental and from rental to ownership to rental are 1.Ø and 1.5 per cent, respectively, with each being modified by the ratio of the rental and ownership price indices.

## 3. DATA SOURCES

Data were collected for the econometric estimations and also as exogenous inputs to the dynamic model. The model utilizes exogenous data for household income, construction costs, inflation, mortgage and bond rates, and the normalized demand. Certain data series had to be derived. The method of derivation is given below for each data series. A list of all data sources use directly by the econometrics, used directly by the model, or used to derive other series appears at the end of this section.

### 3.1 OWNERSHIP DEMAND

Ownership demand was derived by estimating the number of occupied owned housing units. Census data are available for single-detached housing for the years 1966, 1971, 1976 and 1981 (end of second quarter values). Estimates of the occupied single-detached stock for the intercensal period were derived by adding quarterly completions and subtracting estimated demolitions and conversions. Demolitions and conversions were estimated by subtracting the number of single-detached units in one census from the previous Census' number of units plus intercensal completions. The difference was spread evenly over the intercensal period so that the calculated estimate based on the previous Census equalled the new Census single-detached units. The resulting data series was scaled up by the ratio of ownership to single-detached units as reported in the Census.

### 3.2 RENTAL DEMAND

Rental demand was derived by estimating the number of occupied rented housing units, in a manner analogous to the derivation of ownership demand. The only difference was that the category "apartments" was used to estimate the rental stock before scaling up by the ratio of rental units to apartments, as reported in the Census.

### 3.3 OWNERSHIP HOUSEHOLDS - NORMALIZED

The normalized number of ownership households was derived by multiplying the 1981 ownership headship rates to Statistics Canada population estimates (medium scenario). Ownership headship rates were calculated by taking 1981 owned households headed by 8 age-sex groups (Ø-24, 25-44, 45-64, 65+, female and male) and dividing each by the population in that age and sex group for 1981. Those headship rates were applied to the 1966-1981 population data to get the OH series.

### 3.4 RENTAL HOUSEHOLDS - NORMALIZED

The normalized number of rental households was derived in the same manner as normalized number of ownership households, except the rental, rather than ownership headship rates were used.

### 3.5 GROSS NATIONAL EXPENDITURE DEFLATOR

The gross national expenditure deflator was used for the rate of price change. It is more appropriate than the consumer price index since the model is concerned primarily with production, rather than consumption of housing. The series was derived by dividing GNE at Market Prices by GNE Constant Dollars (source: Statistics Canada 13-ØØ1).

### 3.6 REAL INCOME

Real income was derived by dividing disposable income by the GNE deflator.

### 3.7 REAL MORTGAGE RATE

The real mortgage rate was derived by the following calculation:

$$(1 + NMR_t) / (1 + INFL_t)$$

where

$NMR_t$ is the nominal mortgage rate

$INFL_t$ is the inflation rate (rate of change in the GNE deflator)

### 3.8 REAL BOND RATE

The real bond rate was derived in the same way as the real mortgage rate, except the nominal bond rate replaces the nominal mortgage rate in the calculated shown above.

### 3.9 OWNERSHIP VACANCY RATE

The ownership vacancy rate series used for the econometric estimation of the ownership price change equation was the output of a preliminary run of the model.

## DATA SOURCES

| Definition | Source |
|---|---|
| Dwelling starts (single-detached and apartment) | CMHC *Canadian Housing Statistics*, (1985, Table 9) |
| New housing price index | Statistics Canada 62-007, *Construction Price Statistics* |
| Rent Index (CPI, tenant costs) | Statistics Canada 62-002, *Prices and Price Indexes* 62-010, *Consumer Prices and Price Indexes* |
| Gross national income deflator | Statistics Canada 13-001, *National Income and Expenditure Accounts* |
| Construction Costs | Statistics Canada 62-007, *Construction Price Statistics* |
| Mortgage rate 1965-76: conventional mortgages 1977-84: rates quoted by institutional lenders | CMHC, *Canadian Housing Statistics*, (1985, Table 85) |
| Corporate bond rate | CMHC, *Canadian Housing Statistics*, (1985, Table 85) |
| Disposable income | Statistics Canada 13-001, *National Income and Expenditure Accounts* |
| Vacancy rate | CMHC, *Canadian Housing Statistics*, (1985, Table 25) |
| Population | Statistics Canada 91-001, *Quarterly Population Estimates* 11-003, *Canadian Statistical Review* |
| Quality of New Ownership Units | CMHC, *Canadian Housing Statistics*, (Average liveable floor area; 1983, Table 25) |